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THE STRENGTH OF GLASS AS AFFECTED BY DEALKALIZING ITS SURFACE

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EDITOR'S Note: It is the object of this paper to discuss the effect which the dealkalization should have on the mechanical strength and the fatigue endurance of glass. Research along these lines has to be based on average strength values gained by hundreds or even thousands of single tests. Experiments of this type cannot be carried out at the present time in the author's laboratory because of restricted laboratory facilities. The author, therefore, passes along his ideas on this subject with the intention of stimulating research in a testing laboratory of a glass plant.

In a previous paper, H. S. Williams and W. A. Weyl[1] described a process which consists of coating the surface of a glass with metakaolin or a similarly reacting substance and exposing it for a certain length of time to a temperature a little below its softening point. As a result of this treatment the surface is depleted of alkali and assumes properties characteristic of glasses with low alkali content: high chemical resistivity, low electrical conductivity, and low thermal expansion.

The Strength of Glassware as Affected by Furnace Gases during Annealing

On first consideration one is inclined to think that mechanical properties of glass, such as the elasticity and the tensile strength, which are typical volume properties, cannot be affected by a relatively thin surface layer of different composition. Thermal endurance should also fall in this category, because for a given shape of ware, the resistivity against thermal shock is determined by typical volume properties such as thermal expansion, thermal conductivity, specific heat, density, tensile strength, and elasticity. A little reflection, however, will show why this is not so. Experience gained in the container glass industry teaches us that the strength of glassware is affected by its exposure to furnace gases. In addition, it is known to the physicist that the structure of the surface represents a decisive factor in determining the strength of a body.

Due to the great number of uncontrollable variables which determine the strength of glassware, only those data can be considered reliable and conclusive which are based on a large enough number of tests.

J. B. Murgatroyd[2] was one of the first to notice that the reaction of the glass surface with combustion gases had a beneficial effect on the strength. He found that annealing bottles in an open lehr improved the strength from 10 to 20 per cent.

A few years later C. J. Peddle[3] brought further evidence of this improvement. Peddle made a thorough investigation of the influence of the type of annealing lehr on the properties of glass containers. His observations, made in the plant of Forster's Glass Company, Ltd., St. Helens, Lancashire, England, corroborated the earlier experience of Keppeler that the chemical durability of glass increases if the glassware is exposed to furnace gases. From this data we see that the wide-mouth jars have a much lower alkalinity when annealed in an open-fired lehr, due to the reaction of the surface alkali with the furnace gases. The narrow-mouth bottles show higher alkalinity at the inside. Due to surface tension the alkali migrates to the surface but the narrow mouths prevent its reaction with the furnace gases. This effect can be easily understood, but in addition to that, Peddle confirmed the observation of Murgatroyd concerning the influence of the type of lehr on the mechanical strength. The effect of furnace gases on the strength of glassware did not find the same attention, probably because the relation between both was not well understood. Nevertheless, the experimental evidence was striking.

Using two types of pressure tests, snap-bursting pressure, and sustained-bursting pressure, and an impact test he determined the strength of a large number of bottles. The endurance to thermal shock was tested by a boiling water and chilling test.

a. Snap-bursting pressure test:

The bottles are filled with water and put under pres-

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sure by pumping more water into them until they burst. The pressure is increased rapidly, about 100 lb./sec., and the bottles burst a few seconds after the application of pressure begins. The "snap-bursting pressure" is always considerably higher than the "sustained-bursting pressure," but it offers the advantage that a large number of bottles can be tested in a short time. In Table I the results of the snap-pressure test, carried out with fourteen types of bottles (different sizes and shapes), are summarized. The data were collected over a period of about 18 months. Only those results were used which were obtained by simultaneous operation of both the muffle lehr and open lehr so that one part of the ware was annealed in one and the rest in the other lehr. The reliability of Peddle's results can be judged from the fact that altogether over 130,000 containers were tested.

One sees from Table I that the absolute snap pressure varies greatly with the type of bottle, as one would expect, but that in all cases the pressure test indicates a considerable improvement in strength if the bottles were annealed in the open lehr, that means exposed to the combustion gases.

b. Boiling water and chilling test:

Another routine test which was carried out with the bottles was that of filling them with boiling water and observing the per cent breakage. This test was followed by a chilling test in which the bottle while still containing the hot water was plunged into cold water. The degree of chilling, that means the difference between the hot water temperature and the cold water temperature, was adjusted to the type of ware (weight and shape). By experience it was found how much chilling a well-made and well-annealed article will always withstand. Then the chilling was raised 5°C. The added margin

TABLE I.

INCREASE IN STRENGTH OF BOTTLES DUE TO EXPOSURE TO FURNACE GASES (AFTER PEDDLE)

Bottle Type	% Improvement	Average Snap Pressure lbs./sq.in.	
		Open Fired Lehr	Muffle Lehr
1	17.1	607	519
2	12.9	881	780
3	16.5	451	387
4	20.8	875	725
5	13.2	993	862
6	20.4	426	354
7	19.1	598	502
8	21.8	888	729
9	20.1	419	349
10	13.3	582	514
11	18.1	872	738
12	18.1	883	748
13	28.7	1058	822
14	26.1	842	668

insures that the test is severe but not severe enough to break all the ware. Table II shows the results for the boiling water test and the subsequent chilling test made on nearly 100,000 milk bottles. The table brings out clearly that the ware annealed in open lehrs has a better resistivity to thermal shock than that taken from the muffle lehrs.

c. Impact test:

The routine test as it was carried out in the glass plant failed to bring out the differences between the two types of annealing, because only a very low percentage of bottles subjected to this test showed fracture. Peddle, therefore, made this test more severe so that the differences became noticeable. After this adjustment was made, breakage amounted to only 14 per cent of the open lehr bottles but 20 per cent of the muffle lehr ware.

Peddle's data speak for themselves. Despite his convincing results it was hard to understand how the reaction of the glass surface with furnace gases could cause an improvement of a bulk property such as the mechanical strength. The British glass technologists found it desirable to reproduce this effect, using simple glass shapes instead of containers and to work under the more precise conditions of a laboratory. J. Boow and W. E. S. Turner[4] therefore exposed the surface of strips of sheet glass of definite size and known composition to sulphur dioxide. By well established laboratory methods the amount of reaction was determined and expressed in mg. SO_4^{2-}/100cm.^{2}. The modulus of rupture was measured by applying a load at the center of the strip until fracture took place.

Samples which had been exposed to sulphur dioxide for two hours showed an increase in strength but only when the reaction temperature had exceeded 500°C. Although treatment below this temperature leads to the formation of sodium sulphate on the glass surface, the strength of the glass was either weakened or not affected. The authors found that only when the sodium sulphate

TABLE II.

INCREASE IN THERMAL SHOCK RESISTANCE OF BOTTLES DUE TO EXPOSURE TO FURNACE GASES (AFTER PEDDLE)

Test	Bottle	Breakage per 1000 Bottles Tested	
		Open Fired Lehr	Muffle Lehr
Boiling water	half-pint	5	26
	pint	15	45
	quart	62	168
Chilling	half-pint	15	24
	pint	19	39
	quart	32	44
Both tests	half-pint	21	50
	pint	34	84
	quart	93	212

film exceeded 1.5 mg/100cm^2 had the strength increased noticeably. As compared with a sample which had received the same heat treatment in air the modulus of rupture was increased by 17 per cent by the presence of SO_3. The fact that only the high temperature treatment increases the strength, whereas the low temperature treatment results in a weakening of the glass, will be explained later.

Fundamentals concerning the Influence of the Surface Structure on the Mechanical Strength

In order to understand the effect which the withdrawal of alkali may have on the strength of glass, we must

review our present knowledge of the relationship of strength to the physical structure of matter. Unfortunately, there is not too much we can say with certainty. Of all the common properties of glass, strength is the one which is least understood. That is true not only for glass but even for crystals. From the viewpoint of the physicist, sodium chloride represents perhaps the best example of a crystalline solid of simple atomic arrangement. A crystal of rock salt consists of alternately arranged positively charged sodium ions and negatively charged chloride ions. The structure of these ions and their geometrical arrangement in the crystal lattice is well known. We know their charges and distances. From this knowledge it is possible to compute the cohesive force which results from mutual attractions and repulsions. The calculation gives values of approximately 300 kg./mm^2 for the tensile strength. This calculated value is, however, about 600 times larger than the tensile strength found in the laboratory when a sodium chloride crystal is subjected to tension. Comparing the simplicity of the rock salt crystal with the complicated structure of even our simplest glass, we see that any attempt to approach the strength of glasses from the theoretical angle is rather hopeless. Nevertheless, in the past 20 years outstanding contributions have been made to this chapter of physics, especially by A. A. Griffith[5], A. F. Joffe[6] and A. Smekal[7]. These scientists approached the problem from various points of view. Their theories differ in details; but they bring out one important factor very clearly: The strength of brittle materials is not a bulk or volume property as one would expect but it depends, to a large extent, on the structure of the surface. No surface is smooth; each contains flaws or crevices. Fracture under tension starts at the surface, beginning with the widening of crevices under tension. Tensile strength values, therefore, may be raised considerably if the influence of these surface flaws can be eliminated. One way to do so is to distribute the stress in a way that the surface layer does not come under tension. A. F. Joffe[6] carried out this test by heating a sphere suddenly and uniformly. In this case the outside layer expands and stretches the central cold part of the sphere producing uniform tension in the center. G. Grünberg computed the stress distribution for a sphere as a function of time, temperature difference, and thermal conductivity of the material.

Joffe performed the experiment with a sphere of rock salt which he cooled carefully to the temperature of liquid air and then immersed in a bath of molten lead. This treatment did not lead to rupture despite the fact that internal stresses must have reached values up to 60 kg./mm^2.

Glass physicists, too, were aware of the fact that the surface is the place where rupture starts and that in measuring the tensile strength of glass one measures, as Littleton expressed it, the weakness of its surface. J. T. Littleton[8] devised a method to measure the tensile strength of glass without bringing the surface under tension. He used a chilled specimen whose surface was under compression at the beginning of the test and thus obtained much higher values for its tensile strength.

The load carried by a circular glass rod—according to our conventional concept—should be proportional to its cross sectional area

$$W = K\frac{\pi}{4}D^2, \text{ where}$$

W = load carried by the glass rod,
D = diameter of the rod and
K = a constant.

Experiments by A. Threlfall (1890)[9] and A. A. Griffith (1920)[5] and later workers brought out the fact that this relation does not hold true for glasses. The tensile strength of glass fibers increases with decreasing diameter, a phenomenon which Griffith explains by the effect of surface flaws.

In view of these facts F. W. Preston[10] suggested abandoning the traditional concept. Instead of speaking of the "tensile strength" of glass, he introduces the term "surface strength" and bases his suggestion on the following reasoning: For determining the load W carried by the glass rod of the diameter D, two factors have to be taken into consideration. First, that the load W varies directly as the cross sectional area $\frac{\pi}{4}D^2$, and secondly, it varies inversely with the circumference πD. That is

$$W = K_1 \cdot \frac{\pi}{4}D^2 \cdot K_2 \cdot \frac{1}{W \cdot D} = J \cdot D, \text{ where}$$

J is a proportionality factor. Preston's function for the surface strength followed the experimental results much better than the previously used tensile strength.

From these few theoretical results we see clearly that the structure of the surface is an extremely important factor in determining the strength. This is especially true for glasses, where fracture practically always starts from the surface. If the surface layer is under compression surface flaws cannot propagate, they will not influence the strength and as the result, one finds a tensile strength which approaches the much higher value which one would expect from theoretical reasonings.

Previous discussions brought out that the reaction of a soda-lime glass with furnace gases during annealing leads to an extraction of Na_2O from the surface layer. This reaction causes the formation of a skin which because of its lower alkali content must have a lower thermal expansion. On cooling the ware the skin contracts, therefore, less than the bulk of the glass and comes into a state of compression. It is probably this compressed surface layer which accounts for the increase in mechanical strength. Considering that only at higher temperature (400-550°C.) can Na_2O be withdrawn from the surface and chemical reactions below this range are merely base exchange phenomena we can now understand the results of J. Boow and W. E. S. Turner. They found increase of strength only when the glass had reacted with SO_2 at 500°C. or higher. The low temperature reaction which also led to a Na_2SO_4 bloom was a substitution of H^+ for Na^+ rather than a removal of Na_2O and consequently it produced a porous surface and weakened the glass. Earlier explanations that surface imperfection might heal faster under the influence of combustion gases and thus improve the strength are not very convincing. This interpretation lifts the veil of the puzzling and mysterious influence which furnace gases were found to have on the strength of glassware and brings this phenomenon into one line with other well-known processes.

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AN IMPROVED METHOD FOR DETECTING CASEHARDENED GLASS AS A MIRROR COMPONENT

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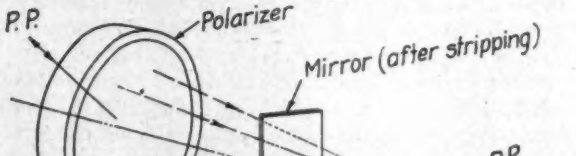
Glass mirrors are often made of casehardened glass for use where they are to be subjected to unusual stresses or shocks, as aboard ship.[1]

Morey[2], in a symposium on glass, reviewed its physical properties. He pointed out that while glass can be broken in many ways, such as by impact, twisting, tension, and compression, the actual breakage is always caused by that component of the force that produces tension. The surface flaws in glass are the main factors limiting its strength since they serve to concentrate the stresses and are the points at which rupture starts. The casehardening process increases the strength of glass by placing the surface under strong compression. The process involves heating the glass to a temperature in the upper end of its annealing range and below its softening range. At such temperature, any stresses in the glass are very quickly relieved. The glass is then rapidly cooled to a temperature near the lower end of its annealing range and maintained at that temperature until the

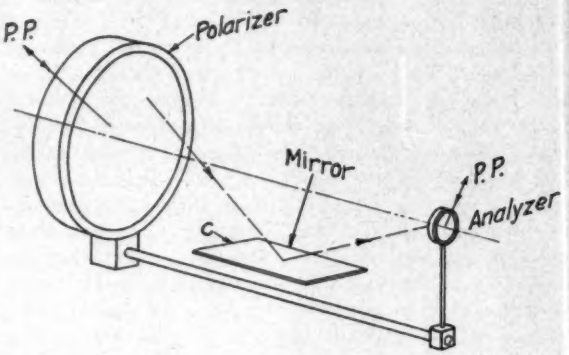


The mirror, after the silvering and other backing have been stripped off, is so placed as to transmit the light from the polarizer. (P.P. = plane of polarization)

Fig. 1

permanent stress introduced by the cooling, which determines the degree of casehardening of the glass, has been decreased to the desired amount. The glass is then cooled to room temperature as rapidly as possible without the introduction of temporary strains that could cause breakage. The resulting casehardened glass is characterized by being strained in certain regular patterns.

The method now in use[1,3] for detecting casehardened glass as a mirror component consists in stripping off the silvering and other backing. The resulting pane of clear glass is placed between the crossed polarizing elements of a polariscope, as illustrated in fig. 1. The effect of the glass on the polarized light passing through it is then observed.



Edge (c) of mirror makes an angle of 45° with plane of polarization (P.P.) of polarizer.

Fig. 2

When the polariscope is used without a tint plate the strain near the edges of the sheet of glass will be visible as colored fringes and the lesser strain in the rest of the glass as light and dark patches. Normally, in order to increase the sensitivity of the apparatus, a tint plate is used with the analyzer and the entire glass appears colored. The unstrained glass has a color dependent on the optical retardation of the tint plate, and the strains are indicated by the characteristic interference fringes.

The above method has two distinct disadvantages. First, the process of stripping off the silvering and the other backing materials, such as paint and electroplated copper, is time-consuming and awkward since it involves scrubbing or soaking in concentrated nitric acid. Second, it is customary and desirable to perform the salt-spray test for corrosion resistance and that for casehardening on the same specimen. While this could be accomplished by performing the salt-spray test first, the visible evidence of the effect of the salt-spray test on the silvered surface would subsequently be destroyed during the casehardening test. This is highly undesirable.

It is proposed that the test for casehardening be performed by means of polarized light which is reflected from the silvered surface of the mirror. This light would be transmitted twice through the glass. The proposed procedure requires no modification of the polariscope as used for observation by transmission.

For best observation of all except the regions near its edges the mirror should be oriented either parallel

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[1] U. S. Navy, Bureau of Ships, Ad Interim Specification 26 M 1 (Int.), for Mirrors (Shipboard Use), dated 15 July, 1942.

[2] George W. Morey, Ind. & Eng. Chem. 32, 1423 (1940).

[3] Navy Department Specification 59 G3 for Glass, Heat-treated, Glazing Rectangular (For Bridge Windows), dated Dec. 2, 1940.

GLASSES TRANSPARENT TO X-RAYS

EDITOR'S NOTE: The following review concerns glasses transparent to X-rays. The first part is an abstract of a paper by L. Ya Mazelev in the *Russian Journal of Applied Chemistry*. Since it appears desirable to compare Mazelev's data on beryllium lithium borate glasses transparent to X-rays with the more extensive data obtained by Menzel and Sliwinski[1] at the time Mazelev's results were published, a digest of Menzel's and Sliwinski's work immediately follows the Mazelev review.

Preparation of glasses transparent to X-rays has been subject of many technical papers and patents. In order to have this transparency it is necessary and sufficient for the glass to contain only elements of a low atomic weight. However, the problem becomes at once much more difficult when it is remembered that in addition the glass must have a sufficient endurance from the chemical, mechanical and thermal point of view. L. Ya Mazelev (*Russian Journal of Applied Chemistry 13*, 1288, 1940) published a helpful contribution to this problem.

In the list of elements arranged according to their atomic weights, lithium, beryllium and boron follow after hydrogen and helium which are not suitable as components of a glass. Mazelev investigated glasses consisting of the oxides of these three elements. First, forty-eight batches were mixed, sintered at 700-900°C, melted at 900-1200°C, annealed at 500-550°C, and examined for their glassy state. The majority of the specimens obtained were found devitrified on cooling. In particular,

all samples containing 15-20% (by weight) of beryllium oxide were found completely devitrified,

samples containing 12.5% (by weight) of beryllium oxide devitrified if the percentage of lithium oxide was below 12.5% or above 15%,

samples containing 10 weight-% of beryllium oxide devitrified if the percentage of lithium oxide was less than 10%,

samples containing 7.5 weight-% of beryllium oxide devitrified if the percentage of lithium oxide was below 7.5% or above 17.5%,

samples containing 5 weight-% of beryllium oxide devitrified if the percentage of lithium oxide was below 5% or above 20%,

samples containing 2.5 weight-% of beryllium oxide gave glasses with 7.5% and with 15 weight-% of lithium oxide; the glasses prepared with a larger amount of lithium oxide (up to 20%) had a tendency to devitrification.

In all these samples boron oxide was the third constituent, so that, e.g., the glass containing 2.5% of BeO and 7.5% of Li_2O contained 90% of boron oxide. As a considerable fraction of lithium oxide and especially boron oxide evaporated during the sintering and melting, all the samples were analyzed after preparation; some of these analytical results are collected in Table I.

The more promising glasses have been tested for their physical and chemical properties.

All these glasses have low softening points, see Table I, and are very "short." Table I includes also data on the density of some glasses. It is seen that the density is the greater the higher the lithium content and the lower the boron content.

The thermal expansion coefficient is given in the Table as an average for the temperature interval 20°-320°C. Above 320°C the expansion depends on whether the sample was or was not annealed. An average has to be taken since the coefficient of expansion is no temperature constant; it gradually increases with temperature for all the glasses investigated. The average coefficient is larger the more basic the glass (i.e. the less boric acid it contains). If a lithium-beryllium-boron glass has to be used as a window in a X-ray tube, its expansion coefficient should be as near as possible to that of the glass of the tube. This latter glass has, in Russia, the coefficient 923×10^{-8} (in reciprocal degrees Centigrade).

TABLE I.

Composition and properties of some $BeO\text{-}Li_2O\text{-}B_2O_3$ glasses.

Composition (Weight-%) BeO	Li_2O	B_2O_3	Density gr./cm³	Index of refraction	Softening point, °C*	Coeff. of thermal expansion x 10⁸	Solubility in water 1%
14.34	16.35	68.87	2.275	1.562	500	891	40.7
14.62	15.50	69.88	2.272	1.558	—	—	36.3
14.08	17.56	68.36	2.279	1.564	485	934	43.0
11.14	13.91	74.95	2.189	1.552	495	742	60.9
11.95	17.82	70.23	2.260	1.564	490	896	48.5
8.82	10.52	80.65	2.100	1.542	495	718	75.1
8.74	17.81	73.45	2.256	1.562	480	800	80.7
5.93	10.57	83.50	2.087	1.538	500	675	86.8
5.90	15.29	78.81	2.148	1.552	498	735	88.6
5.74	22.62	71.64	2.274	1.570	460	940	89.9
3.12	10.39	86.49	2.077	1.535	488	631	91.8
3.03	15.31	81.66	2.113	1.550	490	695	93.6

*From dilatometric observations.

The refractive index for the sodium light of the lithium-beryllium-boron glasses is raised by lithium oxide and lowered by boron oxide.

The absorption of X-rays by the glasses has been calculated from their atomic composition, density, and the absorption capacity of single atoms. Table II gives the composition and the absorption coefficient for the best glasses of Mazelev as well as for two glasses suggested in the Russian patent 47050 (Class 32 B) and two German glasses (see Ziegler and Wellmann, Zeitschr. fuer techn. Physik *14*, 288, 1933, and Lindemann, Zeitschr. fuer Roentgenkunde *13*, 141, 1911).

The water resistivity of the glasses has been tested in the following manner (the glasses were too soluble for standard tests to be applied). The glass was broken down to grains 0.4+0.1 mm. in diameter and dried in an oven. 2 gr. of the dry glass were heated with 100 ml. of water in a conical flask on a water bath for 5 hours under re-

[1] H. Menzel and S. Sliwinski. "Studies on the System, $Li_2O\text{-}BeO\text{-}B_2O_3$ I" Zs. anorg. allg. Chem. *249* (4) 357-385 (1942).

flux. The contents of the flask were filtered, the residue was washed out with water, and the filtrate+wash water evaporated and heated in a platinum dish to 400°C. In this manner the percentage of glass dissolved was determined. The results were checked by weighing the residue which consisted chiefly of beryllium hydroxide. The data collected in Table I show that from the point of view of chemical endurance beryllium oxide is the most valuable constituent: the resistance to water is the greater the greater the beryllia content. In Table II the solubility of the two best glasses is compared with that of the other four glasses previously recommended for the windows in X-ray tubes. The solubility of the glass used for the main body of X-ray tubes was examined as well and, when expressed in the same units, amounted to 0.6%.

TABLE II.

Glasses recommended for windows in X-ray tubes.

Composition (Weight-%) BeO	Li_2O	B_2O_3	Absorption of X-Rays	Solubility, %
Mazelev:				
14.08	17.56	68.36	2.34	43
11.95	17.82	70.23	2.32	48
Russ. P. 47050:				
13.00	15.00	72.00	2.34	48
8.50	20.30	71.20	2.32	72
Ziegler & Wellmann:				
4.40	13.60	82.00	2.22	90
Lindemann:				
2.50	14.75	83.30	2.19	92

* * *

In the following diagrams of the ternary field BeO-Li_2O-B_2O_3 are represented: (1) the area of glass formation (figure 1); (2) refractive index and density (figure 2); (3) chemical resistivity (figure 3). In each figure the weight per cent compositions of glasses according to Menzel and Sliwinski (●), Mazelev (+), the Russian Patent 47050 (■), Ziegler and Wellman[1] (•) and the original Lindemann[2] glass (*) can be compared by their position in the rectangular ternary diagram.

X-ray Transmission

The most important property, X-ray transmission, was not computed because it is practically constant in the area of glass formation. For tungsten radiation at $\lambda = 0.4°$, this constant value is approximately 80 % at 1 mm thickness according to the measurements by Menzel and Sliwinski. Mazelev calculated from density and atomic absorption capacity that the absorption coefficients of his own and other glasses should be about 2.3.

The crucial problem was to find optimum vitrification and chemical resistance in this area of X-ray transmitting glasses.

Limits of Glass Formation (Figure 1)

In figure 1, Menzel and Sliwinski's glass formation boundary is represented by — — — — — — — — —. The following conditions become evident: (1) *Low Lithium Content*—The addition of a small amount of BeO to

1 W. Ziegler and M. Wellmann, Zs. tech. Phys. *14* 288 (1933).
2 A. F. Lindemann, Ger. 223654. See also Glastech. Ber. *6* 312 (1928/29).

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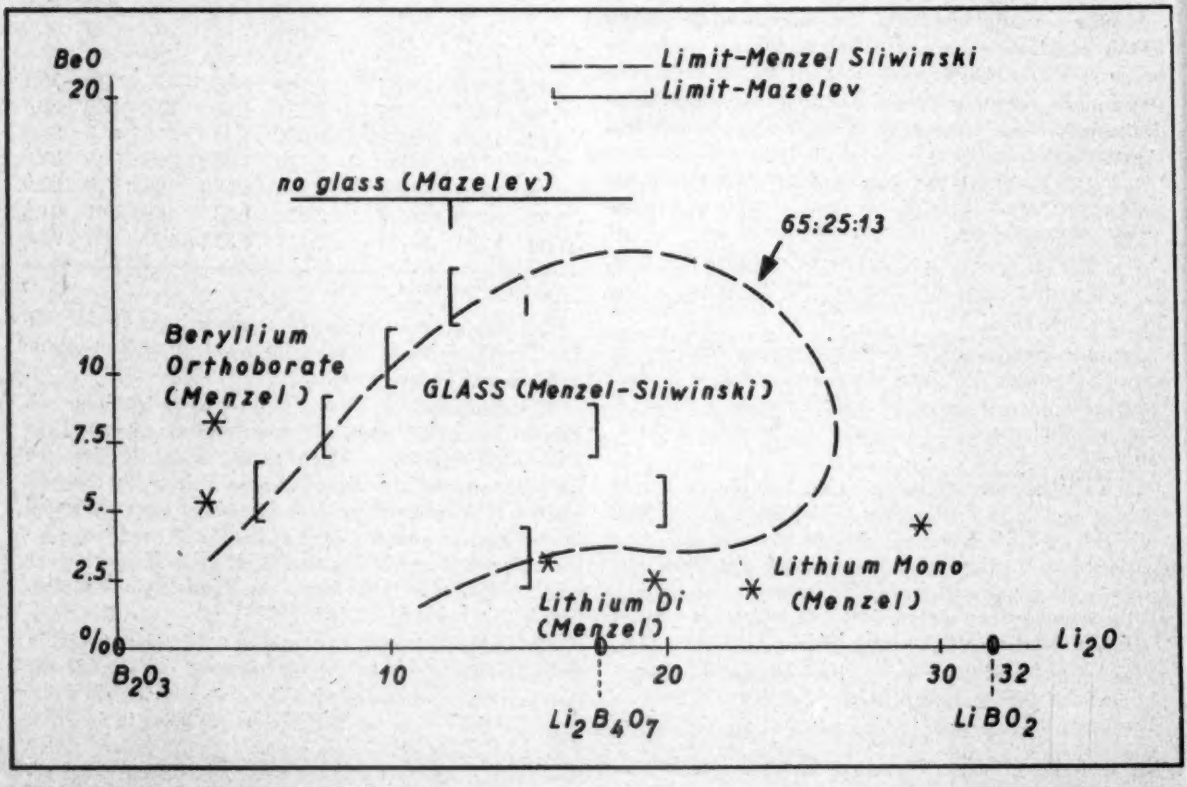


Fig. 1. Field of glass formation. Devitrification.

COLORED GLASSES

A review of a Monograph by W. A. Weyl appearing in "The Journal of the Society of Glass Technology," Sheffield, England

PART IV

The third section (Part IV of THE GLASS INDUSTRY's review) of Weyl's monograph on Colored Glasses, the *study of Non-Ionic Non-Metallic Colorants,* is a most welcome and unique contribution to the puzzling domain of carbon amber, selenium ruby and other glasses containing non-metallic elements in the elemental form. In contrast to earlier publications which were either scanty or highly specific, this section of the monograph is a complete study of the chemistry of sulfur and selenium in glass and includes some references to tellurium and phosphorus.

Several chapters of the monograph elaborate on the equilibrium conditions of alkali sulfides and polysulfides, the latter being the chief chromophores of carbon amber glass. Carbon is discussed in the role of reducing sulfates to polysulfides and a careful presentation of the well known case against the theory of coloration by carbon is given. The concentration of the polysulfides controls the steepness, and the degree of polysulfide formation controls the wave length of the absorption cut-off of these ambers. Small amounts of the cations of heavier elements such as iron modify the color considerably by the introduction of color centers such as iron sulfide and alkali sulfoferrites. A high alkali content is essential in good carbon ambers because it favors alkali polysulfides and sulfoferrites while discouraging the occurrence of grey iron sulfide. The theory linking the carbon amber to the formation of iron sulfide is disproved.

Zinc oxide distroys carbon amber through formation of colorless zinc sulfide thus eliminating the required alkali polysulfides. Since excessive oxidation is disastrous, the use of fluorides and chlorides instead of arsenic, antimony and sodium sulfate is recommended for the fining process.

The knowledge of the reactions of polysulfide glasses can be applied to the elimination of undesirable colorations caused by sulfur.

Sulfur Glass

Of scientific interest is the precipitation of blue elemental sulfur in glasses containing little alkali and much boric or phosphoric acid. These glasses are related to the ultramarine pigments.

Heavy Element Sulfide Glasses

The manifold colors of various sulfides of heavier elements such as Mn, Fe, Ni, Co, Pb, Cd, Cu are discussed on the basis of silicate sulfide equilibria. For the first time the extensive knowledge gained in metallurgy is applied to glass technology. Silicate sulfate equilibria explain the formation of specific sulfides in the presence of other cations, e.g., of CdS in the presence of Co^{++}. A new concept of "striking" color development under heat treatment) of sulfide glasses is suggested on the basis of silicate sulfide equilibria.

Although no true compounds of Na_2O, CdO, S, SiO_2 are present in clear glass, an adequate structural picture can account for analogous changes in the binding forces and positions of the ions Na^{+}, Cd^{++}, Si^{4+}, O^{2-} and S^{4-}. With decreasing temperatures, neighborhoods resembling sodium sulfide and cadmium silicate change to neighborhoods resembling sodium silicate and cadmium sulfide. On further cooling, because of its low solubility, cadmium sulfide separates from the silicate melt. Below its melting point this phase crystallizes and the glass "strikes" to a color dependent upon the number of nuclei corresponding to concentration, solubility, and their subsequent growth.

In practice, sulfide colors are manufactured by the introduction of sulfides, the reduction of sulfates, and the interaction of alkali sulfides or sulfates in the presence of a reducing agent.

The retention of sulfur is favored by zinc ions. Zinc, therefore, aids sulfide color formation. However, this is not true if the sulfide colorant is less stable than zinc sulfide as in the case of antimony sulfide.

Cadmium Yellow

Because of the commercial importance of cadmium sulfide glasses, their properties are discussed in considerable detail. The location of the absorption curve edge is affected by the degree of association and shape of the cadmium sulfide crystals as well as by the presence of some selenium. The desirable sharpness of the absorption curve edge appears to be promoted by high concentrations of cadmium and sulfur which allow a low striking temperature and freedom from impurities.

Selenium Pink

In a very interesting historical introduction to the chemistry of selenium glasses Weyl points out that the older, "colloidal" theory of selenium pink does not take into account the solubility of metals in the elemental state. In the so-called pyrosols a metal is dissolved in a salt in a condition comparable to a frozen-in vapor state. In the selenium pink, selenium is present in this dissolved condition.

The stability of this color is greatly endangered by the possible formation of more reduced or more oxidized anions containing selenium. Reduction leads to brown polyselenides (XSe_n), and colorless selenides (XSe). If iron is present, brown or red iron polyselenides and selenide occur. Oxidation leads to colorless selenites ($XSeO_3$) and, occasionally, selenates ($XSeO_4$). Exces-

(*Continued on page* 392)

INVENTIONS AND INVENTORS

A Summary of Patents of Interest to the Glass Industry Issued During June

Feeding, Forming and Shaping

Fig. 1, taken from patent 2,377,534, granted to Harold A. Wexell and A. H. MacLaren of Corning Glass Works, illustrates an apparatus for reshaping glassware so as to form lipped pitchers. The apparatus consists of a rotatable table upon which there are means for indexing the ware holders, heating the ware, and rolling the lips into the proper shape. The lipping mechanism consists of a lipping roller 15 which moves in a cam slot so as to follow an accurate course as illustrated at 17. It is unnecessary to provide an outer mold but such a shaper 43 is preferable. The movement of the roller is produced by the pneumatic power unit 28 acting through the connecting link 16.

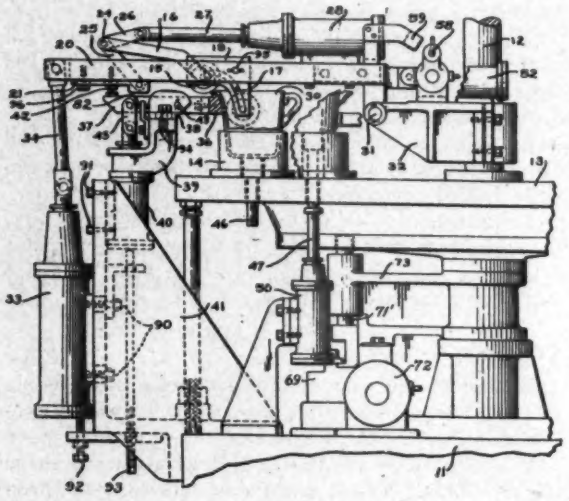


Fig. 1

In the Danner machine for drawing glass tubing the glass is drawn off the end of a rotating tubular member referred to as a mandrel. This mandrel has an axial passage through which air is supplied to the bore of the tubing to support it while plastic. Since the cooling end of the tubing is open to the atmosphere there is a constant escape of the air, which has several practical disadvantages. One of them is that any sublimate from the hot glass is carried forward where it has a harmful action on the surface of the glass. Means of overcoming this are suggested by Charles C. Greene of Corning, N. Y. (Corning Glass Works), in patent 2,377,494. He houses the cut-off and tube removal apparatus so that a positive pressure can be maintained at the open end of the tubing.

The July, 1942, issue of GLASS INDUSTRY told of two forming machine patents granted to Samuel D. Bert of Washington, Pa., and for which ownership was assigned one-third to Maurice A. Yorkin and one-third to James D. Martin. In one of these, 2,282,449, the most interesting feature was the novel means of charging the molds for a pressing operation. The ware was shaped by the action of a plunger, receiving pressure through an aligned air piston; then the plunger slid aside so that the hollow piston could serve as the passageway for the charge for the succeeding piece of ware. A divisional application of this patent has just issued as patent 2,378,176. It is concerned with the mechanism for opening and closing the molds.

Miscellaneous Processes

Patent 2,378,146, granted to Walter O. Luertzing of Vineland, N. J. (assignor to E. Machlett & Son), contains the illustration appearing here as Fig. 2, which shows the manufacture of an inclinometer to be used in aeroplanes. The inclinometer, used as part of a turn and bank indicator, includes a sealed glass tube which is curved and contains a ball immersed in oil. If the plane is in straight level flight the ball lies centrally of the tube at the lowest point of the curve. The manufacture of these tubes presents problems which have only been expensively solved by hand methods. In the mechanical apparatus of Fig. 2 the curved tube is rotated so that a flat closure can be produced by a so-called planar flame which is the result of the impingement of two flames. At the stage of the operations illustrated, the extended end of the tube has already been severed.

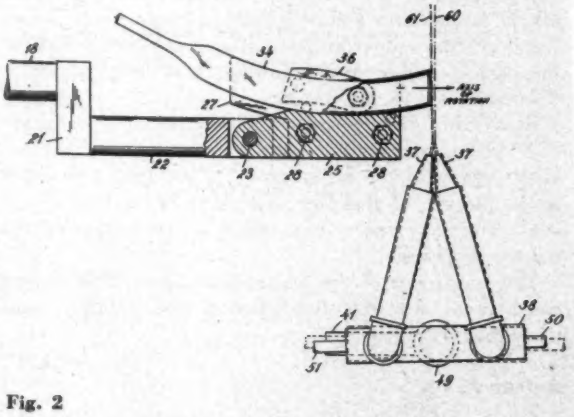


Fig. 2

In tempering such ware as glass tumblers which have internal bends of small radii of curvature it is extremely difficult to equalize the stresses so that a satisfactory temper will be obtained. In patent 2,377,536, issued to Wm. R. Wisner of Corning Glass Works, apparatus is disclosed which is designed virtually to temper only those parts of the article which will be subjected to the greatest shocks and strains in use.

Gustav E. Guellich of Buffalo (American Optical Co.) received patent 2,378,476 for apparatus to be used in applying reflection reducing coatings to glass surfaces. Most of the elements are familiar, for example, the

crucible from which such materials as magnesium fluoride are volatilized within a vacuum and made to deposit upon the glass surface. A new feature is the interposing of a filtering device between crucible and target to filter out any incompletely volatilized particles. This filter is made of graphite, silicon carbide or other material which can be heated by a high frequency induction unit to serve as a radiant for also heating the glass target.

Miscellaneous patents include 2,377,508, granted to Frank L. Michaels of Fort Thomas, Ky., for a light reflecting sign, and 2,378,355 to Ray C. Cobel, assignor to A. H. Heisey & Co., for a glass cocktail shaker.

Indicating the activity of a glass company in the field of fundamental and applied research involving organic plastics is the issuance of seven consecutive patents to Pittsburgh Plate Glass Co., beginning with 2,379,246. In each case the first named inventor is Irving E. Muskat, with Franklin Strain joining him as co-inventor in three of the patents.

Sheet and Plate Glass

Fig. 3 illustrates the new principle used by Wm. J. Hubbard of Libbey-Owens-Ford Glass Co. in patent 2,378,016 for completely uniting laminated glass sandwiches by centrifugal force. This replaces the orthodox treatment by which the unit is given a preliminary pressing and then is enclosed in a rubber bag prior to completion of the process under hydraulic pressure. In this

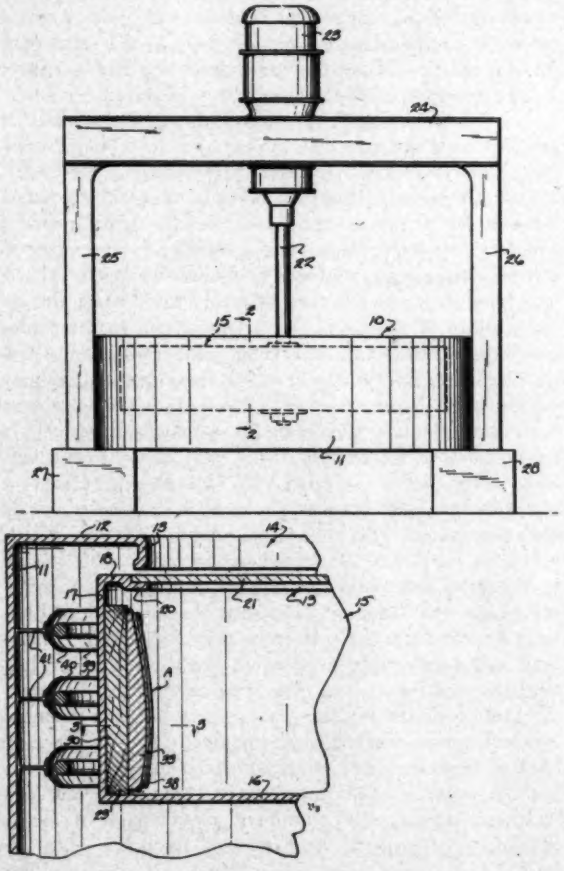


Fig. 3

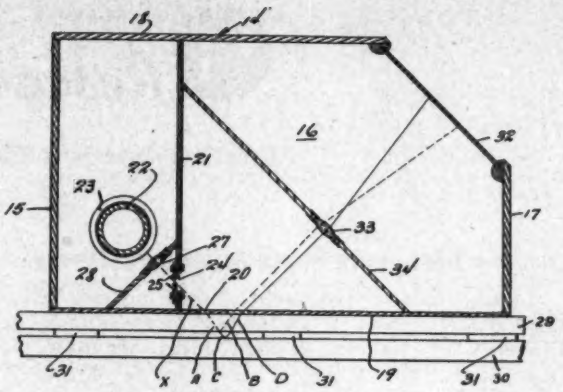


Fig. 4

latest method a centrifuge of the type shown in the upper view is used. The lower sectioned view shows how the sandwich, this time of bent sheets, is laid against a plaster of paris form 33 and held to it by clamps 38, or even by Scotch tape. Electric resistance units 39 are provided within the centrifuge housing, and outside the spinning container so that the glass may be heated to the proper temperature to soften the plastic interlayer.

Other Libbey-Owens-Ford patents are 2,378,031 to Ormond H. Paddock for a multiple glazing unit, and 2,377,849 to Carl F. Binkert and Joseph E. Jendrisak for a process for bending glass sheets. The latter method used a concave mold of a shape which will produce a spherical type bend. The sheet to be bent is arranged upon the mold with its edges entirely within the actual shaping area, in contact with the bending surface and free to move over it; the sheet is then prebent by heating which causes it to soften and sink partially into the mold by gravity until the marginal portions of the sheet are in contact with the bending surface; finally suction is applied from below to draw the entire preheated sheet downwardly into the mold.

An apparatus for determining the flatness of glass plates, described in Benj. H. Vine's patent 2,379,263 (Pittsburgh Plate Glass Co.), is illustrated in Fig. 4. This consists of a cabinet housing a light source 22 such as a fluorescent tube, from which light is intensified by an elongated optical element 27 and allowed to move obliquely through slots 24 and 20. The cabinet rests upon the plate 29 being tested which is separated from a standard reflecting surface 30 by felt strips. The band of light is in part reflected from the lower surface of the test plate, but the main portion of the beam is reflected from plate 30. These two beams pass through a second lens to register on a ground glass viewing plate 32, here presenting two images of the slot 24. If there is any bowing of the plate being tested this will alter the spacing of these two images. A local bow downward will bring the two plates closer together and will in turn bring the two light bands or images closer together. An upward bowing will have the opposite effect.

Joseph A. McCormick, Jr., of Forest Park, Ill. (Dearborn Glass Co.), has received a third patent 2,378,091 on his method of separating sheets of glass into smaller units, for instance, in cutting a disc from the center of

(*Continued on page* 398)

GJ Research Digest

Practical Interpretations of Glass Technology

Contact Deposits In An Artificial Silicate Magma

In an article on geochemistry which appears in the May 15, 1945, issue of the *Journal of the Washington Academy of Sciences*, Herbert Insley discusses the changes that take place in alumina-silica refractories when used in glass tanks. Part of this discussion follows.

That part of the aluminum silicate refractory above the level of the molten glass is subject to reaction with the tank atmosphere. This atmosphere contains the unburned fuel gases and the products of combustion as well as volatilized alkalies and the batch dusts composed largely of alkali carbonates with smaller amounts of the coarser-grained quartz and limestone. Usually the ratio of alkalies to lime and silica is much higher in the tank atmosphere than in the molten glass. The action on the aluminum silicate refractory above the glass level is in general a decomposition to form crystalline alumina (αAl_2O_3, or corundum) in a liquid sodium calcium aluminum silicate. On vertical or sloping side walls the platy crystals of corundum tend to form a network from which the silicate liquid drains away into the glass in the tank often leaving a thick crust of corundum crystals. At times the corundum crystals are carried into the tank glass with the liquid silicate to form troublesome and relatively insoluble "stones." Where the liquid is retained on the refractory wall it may sometimes crystallize to a plagioclase feldspar or, more rarely, to nephelite.

The reaction to form corundum and liquid in the aluminum silicate refractories exposed to the glass furnace atmosphere at operating temperatures takes place even though the refractory block has a composition more highly siliceous than that of a pure dehydrated kaolinite (Al_2O_3—46 per cent, SiO_2—54 per cent) where one might reasonably expect an aluminum silicate such as mullite to form. A consideration of the solubility relations in the system Na_2O-Al_2O_3-SiO_2 at these temperatures shows the reason for the phases present. The boundary of the primary phase fields of mullite ($3Al_2O_3$-$2SiO_2$) and corundum (Al_2O_3), which in the Al_2O_3-SiO_2 system lies at a SiO_2/Al_2O_3 ratio of 46/54 bends sharply toward the SiO_2 apex in the presence of Na_2O until it reaches a composition in which the ratio is 78/22 and the Na_2O percentage is 10. This represents a deep salient of the corundum primary phase field into the ternary system and in effect means that at the operating temperatures of glass tanks corundum may be the product of reaction between aluminum silicate and soda where the original blocks were considerably higher in silica than kaolinite and which, therefore, may have contained originally considerable quartz. Moreover, close to the quintuple point albite-mullite-corundum-liquid-vapor the isotherms indicate that corundum may be a product of crystallization from the liquid at temperatures as low as 1,100°C., although there is a very sharp increase in liquidus temperatures toward the Al_2O_3 apex of the diagram. The diagram of the K_2O-Al_2O_3-SiO_2 system indicates the same strong inclination of the corundum-mullite boundary toward the silica apex as in the Na_2O-Al_2O_3-SiO_2 system. In the CaO-Al_2O_3-SiO_2 system, the inclination of the mullite-corundum boundary is also toward the silica apex, although it is not nearly as pronounced as in the other two diagrams.

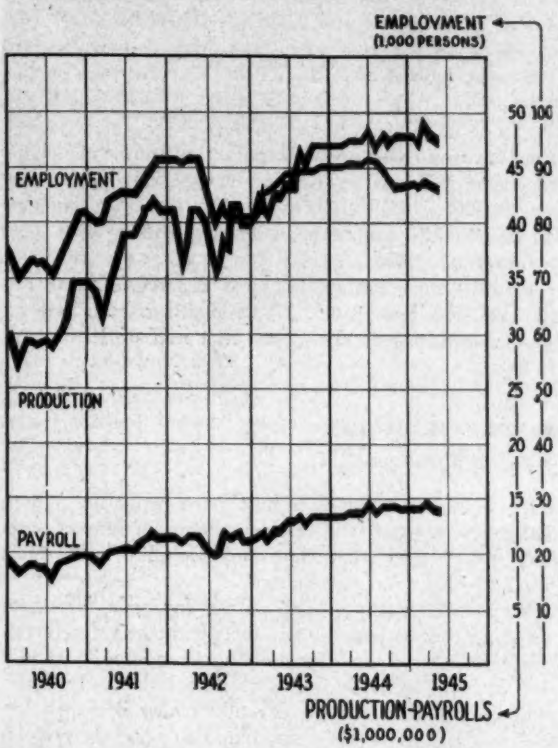
Approximately the same reaction products are formed at the contact of molten glass and aluminum silicate refractory as are formed above the level of the molten glass, although the relative quantities are much different largely because of the fact that considerably greater percentages of silica and lime take part in the reaction in the former case than in the latter. In the reaction between glass and refractory, moreover, both of the reaction products, corundum and liquid, are carried away from the reaction face, thus continually exposing new material to attack. In fact, both above and below the glass line the reaction is a non-equilibrium process even over very short distances. Mullite and glass are the products produced in the manufacture of the refractory. In refractories below the glass level the first evidence of the reaction of the molten glass is shown by an increase in the amount of glass with respect to that of mullite with the eventual appearance of tabular rhombohedrol crystals of corundum layer (next to the glass) frequently contains skeleton crystals of nephelite sometimes associated with carnegieite. In the meeting end of the tank the temperatures are generally far too high to permit the formation of the nephelite-carnegieite phase, and here the crystallization probably takes place during the cooling of the tank after a campaign. In the cooler portions of the tank operating temperatures are frequently within the range in which these compounds may crystallize. Below the glass level, as well as above, corundum crystals may form as a reaction product on refractories in which the Al_2O_3/SiO_2 ratio is considerably below that of kaolinite (46/54). Even a refractory material that contains enough excess silica for considerable free quartz may produce corundum with the molten glass. In xenoliths of refractory material which have been carried away in the magma varying degrees of metamorphism and digestion have been observed. Pieces that have broken from the refractory near the exit end of the tank and presumably exposed to reaction at fairly low temperatures for a short time may have slight evidences of solution of the mullite crystals with a few extremely thin corundum crystals at the contact. In others which have undergone longer attack at higher temperatures, the mullite crystals have disappeared completely and the inclusion has a core composed of a mass of small corundum crystals in a matrix of nephelite with an

(*Continued on page* 380)

CURRENT STATISTICAL POSITION OF GLASS

THE GLASS INDUSTRY'S INDEX

Monthly Trends Through May, 1945



Activity in the glass industry during May dropped somewhat from the figures reported for April. The Production Index for May shows an amount of $47,000,000 as compared to $48,000,000 for April. The May 1944 Index reported $48,000,000. Production for the first five months of 1945 totalled $238,000,000.

Plate glass production for June, as reported by the Hughes Statistical Bureau, amounted to 6,081,137 sq. ft., which is a drop of about 29 per cent from May's total. This figure also represents a drop of a little more than 34 per cent from that which was reported for June 1944. The first half of 1945 shows a total plate glass production of 48,481,127 sq. ft., as compared to 51,163,496 sq. ft. produced during the same period last year.

Glass container production for June totalled 8,702,164 gross—a 6 per cent decrease under May 1945 and a little more than 2 per cent decrease under June 1944. Glass container production for the first six months of 1945 shows a total of 50,860,610 gross. For the same period in 1944, the total production was 51,274,365 gross. Shipments for the month of June were 9,054,635 gross which is a little more than 2 per cent under the 9,269,759 gross totalled for May. During the first half of 1945, shipments of glass containers totalled 52,450,567 gross as compared to 49,484,524 gross in 1944—an increase of slightly more than 5 per cent.

June glass container inventories totalled 3,985,804 gross in comparison to 4,443,620 gross in May—a difference of a little over 10 per cent. June 1944 inventories totalled 4,947,222 gross which is 19 per cent more than for June 1945.

Automatic tumbler production for June totalled 5,951,009 dozens which is about 1 per cent more than May's production of 5,879,960 dozens. June 1945 production is approximately 27 per cent greater than for June 1944 which totalled 4,679,355. Shipments for June were 5,833,977 dozens as compared to May's 5,566,235

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures Are in Gross)

		Production June, 1945	*Stocks June*, 1945
Foods; Medical & Health Supplies; Chemical, Household, Industrials; Toiletries & Cosmetics	Narrow Neck	2,847,482	1,736,672
	Wide Mouth	2,687,699	932,645
Dairy Products		277,175	207,575
Home Canning		288,695	303,156
Beverages, Returnable		694,564	364,619
Beverages, Non-Returnable		—	—
Beer, Returnable		545,844	64,760
Beer, Non-Returnable		419,663	37,383
Liquors		652,624	230,954
Wines		201,137	58,059
Packers' Tumblers		87,281	49,981
Total		8,702,164	3,985,804

GLASS CONTAINER SHIPMENTS

(All Figures Are in Gross)

	June, 1945
Narrow Neck Containers	
Foods	684,838
Medical & Health Supplies	1,079,951
Chemical, Household, Industrials	563,285
Beverages, Returnable	690,289
Beverages, Non-Returnable	—
Beer, Returnable	534,328
Beer, Non-Returnable	403,117
Liquors	621,834
Wines	218,630
Toiletries & Cosmetics	560,234
Sub-Total (Narrow Neck)	5,356,506
Wide Mouth Containers	
Foods	2,206,869
Dairy Products	303,263
Home Canning	322,396
Medical & Health Supplies	284,407
Chemical, Household, Industrials	109,476
Toiletries & Cosmetics	161,449
Packers' Tumblers	94,550
Sub-Total (Wide Mouth)	3,482,410
Total Domestic	8,838,916
Export Shipments	215,719
Total Shipments	9,054,635

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dozens and the 5,254,227 shipped during June 1944. Finished stocks on hand as of the end of June were 4,691,327 dozens as compared to 7,062,716 in June 1944.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware for June were reported at 2,767,019 dozens as compared with 2,405,487 shipped in May. That is, about 15 per cent more than May shipments. June 1944 was figured at 2,013,579 or 37 per cent less than June 1945.

Employment and payrolls: The number of people employed in the glass industry during the month of May was 86,600. This is slightly less than the figure reported for April 1945. Employment figures for May 1944 were reported at 91,600.

Payrolls during May estimated $13,000,000 which is $500,000 less than April. $70,000,000 has been paid by glass manufacturers during the first half of 1945.

RESEARCH DIGEST . . .

(*Continued from page* 378)

outer zone composed of almost pure nephelite. Where reaction has gone still further, the corundum crystals have disappeared completely and nephelite is the only crystalline material remaining.

A partial substitution of potash for soda, produces the same general reaction products with the refractories. The feldspathoid associated with corundum is in this case a nephelite-kaliophilite solid solution. In lead-containing optical glasses corundum also is a product of the reaction between molten glass and refractory even in the absence of alkalies.

The solution of the technological problem of increasing the resistance of the refractory to corrosion by molten glass would appear to be simple from the purely chemical point of view after the products of the reaction have been identified. A moderate increase in the alumina content of the refractories may, however, do more harm than good because solution of the more soluble phase in the molten glass may release abundant, relatively unsoluble corundum crystals into the glass and cause the rejection of ware because of "stones." If the refractory can be made out of homogeneous, nonporous, pure alumina, then whatever slight solution there is will be uniform and do little or no damage to the glass. Technical difficulties in the manufacture of a mechanically stable refractory of this type are numerous, however, and so far it has not been satisfactorily solved.

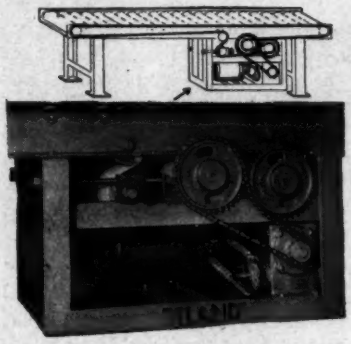
WESTINGHOUSE NAMES MANAGER KEN-RAD LAMP DIVISION

It has recently been announced by Westinghouse Electric Corporation that Robert F. Tucker will assume duties as Manager of the recently acquired Ken-Rad Lamp Division.

Westinghouse took over the Ken-Rad lamp plant at Owensboro, Kentucky, and it is stated that Mr. Tucker will be responsible for the Division's manufacturing, engineering and sales operations.

NEW EQUIPMENT AND SUPPLIES

NEWLY IMPROVED POWER-PAC



The Island Equipment Corporation, 101 Park Ave., New York, N. Y., has recently placed on the market an efficient power unit for motorizing conveying equipment known as "Power-Pac." It is a self-contained assembled unit, built solidly in an iron frame, ready to be quickly and securely bolted to the chassis of any piece of conveying equipment that needs to be mechanically operated.

The unit consists of all the necessary mechanisms to enable the user to make the proper connections to his equipment — plug into a proper electric socket and it is ready for use. The entire unit measures 15 x 24 x 17 inches and weighs but 167 lbs. crated for shipment. The main Pillow Block Housings to which are attached the main drive rollers allow ample lubrication at all times.

IMPROVED PLATINUM THERMOCOUPLE ASSEMBLIES

The Brown Instrument Company, Philadelphia, Pa., reports marked improvements in platinum thermocouple assemblies used with two-hole silica blocks for glass tank crowns. The improvements will result, it is said, in longer service life for the protecting tube assembly and will facilitate removal of the thermocouple assembly for periodic inspection.

The major improvements consist of replacing with heat resisting stainless steel the secondary protecting tube previously made of steel. The change, it is claimed, will reduce oxidation to a minimum, eliminate freezing of the tube and permit its removal for inspection.

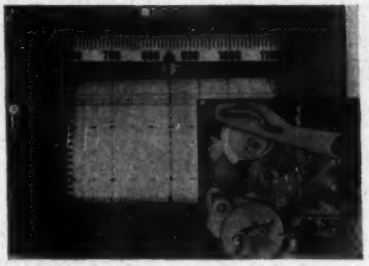
NEW THREE-PURPOSE WELDING ELECTRODE

Air Reduction Sales Company, 60 East 42nd Street, New York 17, New York, has announced a new combination type welding electrode, Airco No. 315, designed to produce horizontal fillet welds with flat or slightly concave profiles and concave fillets in the flat position, as well as satisfactory deep fillet and deep groove.

Usual applications for the new electrodes include pressure vessels and their connections, heavy machine weldments and practically all heavy steel assemblies where high weld quality is important. The new Airco No. 315 can be used for any job that calls for a 6020 or 6030 electrode and may be applied with either the alternating or direcet current, straight or reverse polarity.

NEW SPEED GEARS BY BROWN

Brown Instrument Company, Philadelphia, Pa., reports that increased industrial use of electronic recorders has been made possible by stepping up chart speeds of Electronik Pyro-Potentiometers. It is said that the standard speed electronic recorder, single or multiple point models, incorporates gear changes for speeds of 5, 10, 15 and 20 inches an hour.



Fast speed electronic models, single or multiple point, will have internally mounted gears for speeds of 10, 20, 30 and 40 inches an hour.

As shown in the illustration, the gears are changed by removing screw "C" from gears "A" and "B" and by lifting the gears from the assembly. The new speed gears are then installed and screw "C" is replaced.

NEW VAPOR COLLECTOR

Aget-Detroit Company, 602 First National Building, Ann Arbor, Michigan, announces a new addition to the line of Dustkops for the purpose of stopping and collecting vapor from oil or cutting fluids arising from cutting, grinding and similar operations and returning it to the source of its supply.

The new vapor collector is for use on practically any type of high speed production machine tools employing cutting oils or coolants such as screw machines, thread grinders, centerless grinders, wet carbide tool grinders, etc.

Installation is quickly made with either ordinary sheet metal pipe or flexible metal hose of 5-inch diameter which fits the inlet flange of the collector and can be located near the source of the vapor.

The standard motor to drive the fan and provide the suction is ½ hp, 3450 rpm, continuous duty type, for operation on 220 volt, 3 phase, 60 cycle alternating current. Units for operation on power sources of other voltage and frequencies are available on order.

CATALOGUES RECEIVED

The Wirebound Box Manufacturers Association, 43 East Ohio Street, Chicago 11, Illinois, has published a new booklet featuring modern shipping containers that enable a product to be packed in less than a minute. Entitled "Your Product . . . How to Ship It Safely at Lower Cost," the pamphlet explains that modern wirebound containers save vital man hours in a shipping department, cut shipping costs and conserve space in a shipping room.

The illustrated booklet covers strength, assemblage, storage space and tests that are made to assure maximum protection of a product. After a product is checked carefully for weak spots, fragility, weight distribution, etc., a wirebound box or crate is engineered with the proper thickness of wood, size and number of cleats, number and diameter of binding wires for best shipping protection.

The Carborundum Company, Niagara Falls, New York, has made available an 84-page book entitled, "Sanding and Finishing," to acquaint coated abrasive users with the newly announced system for identifying coated abrasives by Carborundum.

The book contains information about coated abrasives, including a complete explanation of the new system and new End Use names for all coated abrasive products.

The Jeffrey Manufacturing Company, Columbus 16, Ohio, has published an attractive 60-page catalogue on their Coal and Ashes Handling Machinery for power plants and boiler houses (No. 778). This catalogue illustrates and describes in a brief way the various Jeffrey units which combine to make practical arrangements for meeting any plant layout or capacity.

Some of the subjects covered are: Silo Storage Systems; Typical Coal Handling Systems for Plants of Medium and Large Size; Plate Feeds; Bucket Elevators, etc.

Walker-Jimieson, Inc., 309 Western Avenue, Chicago 12, Illinois, has just published a new catalog of Radio and Electronic Equipment. Its contents include pertinent information and data on the most advanced types of electronic instruments, devices and tools. Descriptions of products such as Industrial X-Ray Machines, Electronic Comparators, Test Equipment and others never before catalogued are included in this volume.

(*Continued from page* 374)

pure B_2O_3 leads to devitrification. As lithium is added, the presence of an excess of BeO over Li_2O leads to devitrification. The crystalline phase is a hitherto undescribed beryllium borate. 2) *Medium Lithim Content*—Conversely, in the absence of BeO, devitrification occurs at about 10 per cent Li_2O. The addition of some, but not more than 10 per cent, BeO prevents devitrification. The crystalline phase is lithium diborate. (3) *High Lithium Content*—Beyond 20 per cent Li_2O, the area of glass formation is restricted to a narrowing field of 5-10 per cent BeO until at about 25 per cent Li_2O glass formation ceases to occur. The devitrification phase is lithium monoborate. (4) *Mezelev's Limits*—At the low lithium boundary, Mazelev's limits of glass formation as given for 12·5, 10, 7·5, and 5 per cent BeO are in excellent agreement with the boundary drawn by Menzel and Sliwinski. Mazelev's limits are symbolized by [ ] in the diagram of figure 1. In the high lithium area, the few values by Mazelev lead to an apparent limitation at much lower lithium and beryllium contents. It so happens that chemical resistance is particularly high in the area beyond the line 20 per cent Li_2O—5 per cent BeO and 15 per cent Li_2O—10 per cent BeO, where Mazelev's data become scarce.

Refractive Index and Density (Figure 2)

Figure 2 reveals reasonable agreement on the approximate field of refraction and density as given in the two publications. Mazelev's indices seem somewhat higher than Menzel's. Towards high BeO and Li_2O contents the index and density rise from about 1.50 and 2.02 to 1.57 and 2.27.

Chemical Resistance (Figure 3)

(1) *Testing Method*—Menzel and Sliwinski tested the rather hygroscopic glasses of this field by weighing the vapor adsorbed with a carefully dried powder sieved through 4900 mesh per cm^2 and exposed to 60 per cent humidity at 24°C for 30-100 days. Results are expressed in per cent of the weight of the dry glass and given in italics on figure 3. Mazelev expressed resistivity as water solubility in percents represented in regular print on figure 3.

(2) *Low Li_2O Content*—It may be seen that glasses containing more than 80 per cent B_2O_3 are highly hygroscopic and more so the less BeO they contain. At equal BeO contents the increase in Li_2O decreases hygroscopy. Solubility tests of Mazelev and vapor adsorption tests of Menzel-Sliwinski show qualitative correlation.

(3) *High Li_2O and BeO Content*—In the area of 65-80 per cent B_2O_3, the vapor adsorption decreases rapidly. Detailed conclusions are impossible because variations are within the order of experimental uncertainty. However, in this area must be located all X-ray transmission glasses of importance. Mazelev's smaller amount of data does not show as clearly that this field exists nor how large it is and how much resistance in this area improves. However, his solubility data near this area show clearly

(*Continued on page* 384)

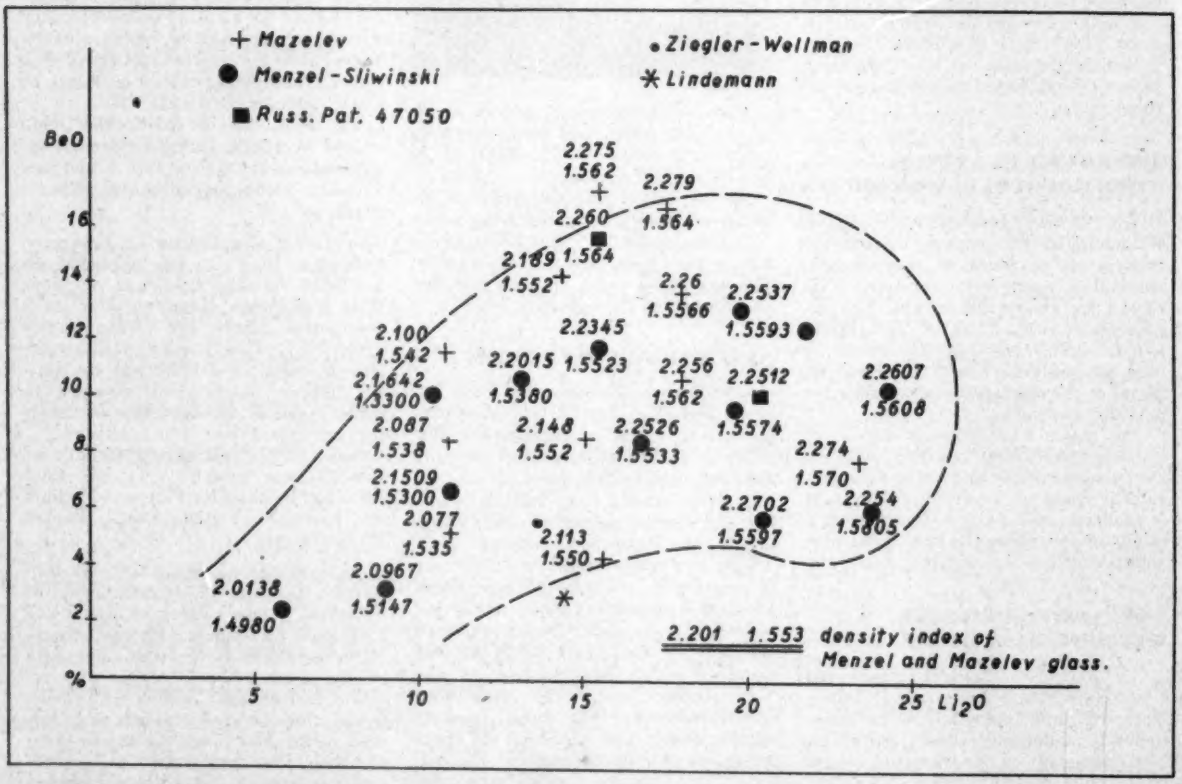


Fig. 2. Density and refractive index in the system BeO-Li_2O-B_2O_3.

RUTGERS ORGANIZES BUREAU OF MINERAL RESEARCH

In an effort to rehabilitate and expand New Jersey's mineral industry, Rutgers University has recently organized the Bureau of Mineral Research to make a geological and ceramic study of the State's mineral resources.

It has been announced that Dr. Alfred K. Snelgrove, chairman of the Department of Geological Engineering of the Michigan College of Mining and Technology and geological consultant to the government of Newfoundland, has been appointed professor of geology at Rutgers and director of the bureau. Dr. Snelgrove will work in close cooperation with State Geologist Johnson, who has been named as a research associate in geology at Rutgers. Paul M. Tyler, mineral economist on leave from the U. S. Bureau of Mines, has prepared a detailed plan for the mineral resources study.

Organized because of the steady decrease in output by New Jersey's mineral industry, members of the new Bureau believe that with greater knowledge of New Jersey's mineral resources, particularly those of a nonmetallic character, and with the technological developments of recent years, new mineral industries can be brought to New Jersey, old ones revived and current operations increased. The state, which had once been an important exporter of various sands and clays, has become an importer of some of these products while local deposits lie idle or are being worked on a steadily diminishing scale.

CORNING ENGAGES HOME ECONOMISTS

To fill new posts as field representatives in the four major sales districts of the company's Consumer Products Division, Corning Glass Works has announced the recent addition to its staff of four graduate home economists. All four women have had experience in the educational and selling fields, as well as in nutrition and dietetics, and have recently completed a training program in the Corning test kitchen.

It is stated that the work to be done by the women will be supplementary to that of the regular sales force in that they will assist in the education and training of sales personnel in retail stores stressing the selling points of Corning products and will assist in the display and promotion of these products.

The representatives will make regular calls at educational and social service institutions and public utility companies in addition to the work outlined above.

WPB EASES RESTRICTIONS ON NEW GLASS MOLDS

The War Production Board has announced that manufacturers of glass containers may make new glass molds for experimental purposes provided they conform to certain requirements.

Experimental molds for non-standard bottles, glasses or jars may be made by a manufacturer and, since the machines in such factories are usually designed to carry a complete set of molds, the manufacturer may make a complete set of molds for any one of his experimental models. He may not, however, make more molds than are required for one machine, nor make a duplicate set of the molds at some other plant under his ownership.

HAROLD BOESCHENSTEIN AWARDED DEGREE

Harold Boeschenstein, president of Owens-Corning Fiberglas Corporation, was awarded an honorary degree of doctor of laws by Bowling Green State University, Bowling Green, Ohio, at the University's annual commencement. Mr. Boeschenstein is serving as operations vice chairman of the War Production Board at the present time.

Shown with Mr. Boeschenstein, who is at the extreme right of the photograph, are Carl E. Steeb, business manager of Ohio State University; the Honorable Frank J. Lausche, governor of Ohio; President Frank J. Prout of Bowling Green State University.

METROPOLITAN NEW YORK SECTION OF A. C. S. BEING FORMED

At an informal meeting held at the Chemists Club in New York on July 18, an application for charter for a Metropolitan New York Section of the American Ceramic Society was signed by ten A.C.S. members attending.

The meeting was presided over by Joseph A. Pask of Westinghouse Electric Corporation, Lamp Division. James B. Austin, U. S. Steel Corporation, and a trustee of the Society, served as Councillor.

Others who attended the meeting and signed the charter application were James F. Barnes, Carnegie-Illinois Steel Corporation; J. C. "Sam" Crawford, Johns-Manville Corporation; Cyril B. Delgado, The Glass Industry; Emerson W. Emerich, R. T. Vanderbilt Labs; Frank J. Fallon, B. G. Corporation; Perry C. McCollum, American Crucible Company; Elmer Rosenberg, DeMuth Glass Works, Inc.; James D. Tetrick, Metal Thermit Corporation. A meeting has been scheduled for September 5.

PENNSYLVANIA SALT ANNOUNCES NEW APPOINTMENT

Pennsylvania Salt Manufacturing Company, Philadelphia, Pa., has recently announced the appointment of Frank E. Murphy as Director of Development Division, Research and Development Department.

Formerly Assistant to Manager of this department, Mr. Murphy will have charge of chemical engineering activities in his new capacity. He will be located at Whitemarsh Research Laboratories although much of his work will be carried out at various company plants.

GLASSES TRANSPARENT TO X-RAYS . . .

(*Continued from page* 382)

that an increase of resistance takes place. (Solubilities 40 around 17 per cent Li_2O; 80 in the higher B_2O_3 field.) In this area are located the glasses according to Russ. Pat. 47050 symbolized by ■.

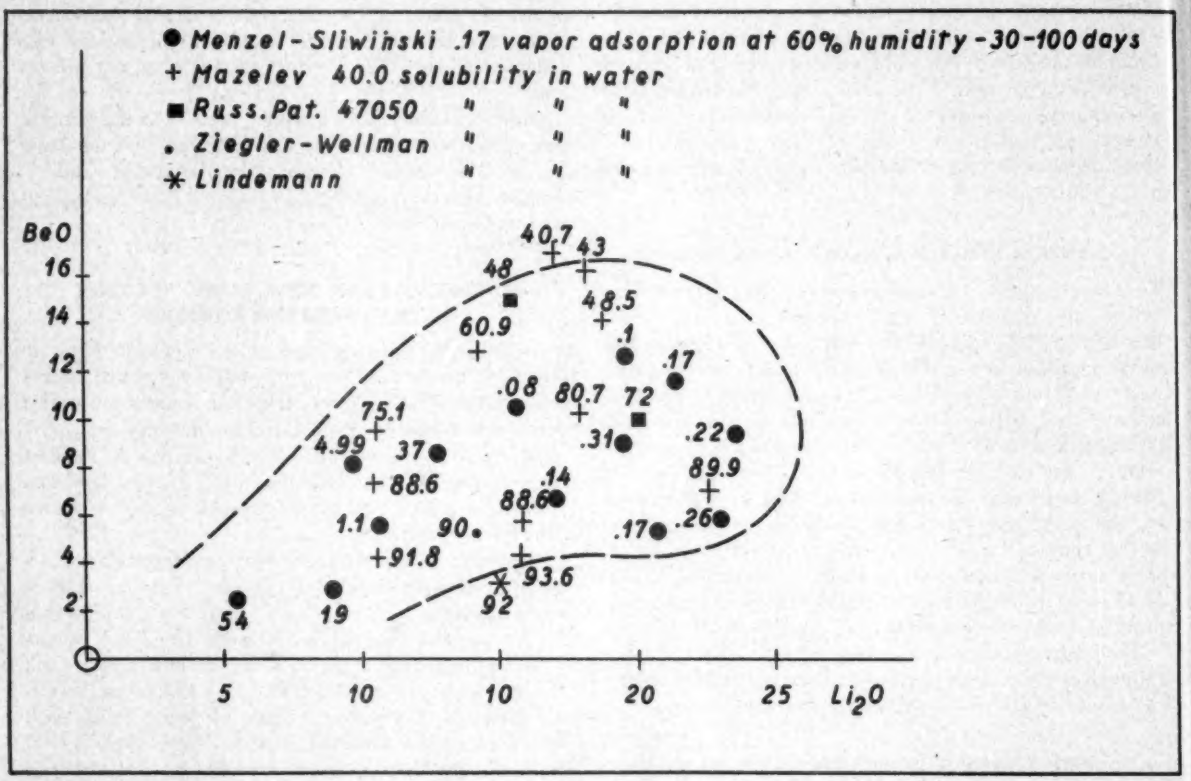
(4) *Glass by Hertzruecken et. al.*—The glasses in this field, described by Hertzruecken et. al. [1, 2] cannot be evaluated since—as Menzel and Sliwinski point out—their composition is doubtful. A carbonate of beryllium, which is known to be a basic salt of variable composition, was used as a primary material and the glasses were not analyzed. Hertzruecken's assumption that stability should be based on certain stoichiometric formulæ is untenable in the light of the present concept of glass constitution.

(5) *Wellmann's Glass*—The one glass by Ziegler-Wellmann given on the graph (figure 3) (•) is not in a particularly suitable area. Again the reliability of data given by these authors is doubted by Menzel and Sliwinski because of the use of a "$BeCO_3$" preparation of uncertain analytical composition. A patent by these authors[3] claims particular resistance and freedom of devitrification tendencies for this glass and it is reported that an addition to this patent including combinations with some K_2O and Na_2O has been applied for.

(6) *Lindemann Glass*— The original Lindemann glass, the first in this interesting glass family, happens to fall in the least desirable boundary area of the field, where tendency for vitrification and resistance are small. This becomes evident from figure 3, where this glass is symbolized by the asterisk (*).

1S. Hertzruecken and K. Tantschakivsky, J. du Cycle de Phys. et de Chim. 1 (4) (1933).
2S. Hertzruecken, Techn. Phys. USSR *3* 336 (1936), J. tech. Phys. *6* 931 (1936).
3Ger. 537633 (32/b).

Fig. 3. Chemical resistivity in the system BeO-Li_2O-B_2O_3.



PASCOE RETIRES FROM AMERICAN WINDOW GLASS

The American Window Glass Company has recently announced the retirement of C. H. Pascoe. Mr. Pascoe has served with the company for many years in the capacity of Director of Sales.

Howard H. Parker will take over Mr. Pascoe's duties as Director of Sales, and will have Kenneth S. Wilson as his assistant.

INLAND STEEL COMPANY ACQUIRES HILLSIDE FLUORSPAR

Announcement has recently been made that the Hillside Fluorspar Company, Rosaclaire, Illinois, has been dissolved and is now owned and operated by Inland Steel Company, Chicago, as a division of that corporation.

Joseph C. Keaney of Pittsburgh, for many years distributor of ceramic grade fluorspar for the Hillside company, will continue in that capacity under the new set-up.

PROGRESS WITH CORHART

The Corhart* Electrocast balanced tank shown above recently completed its second Corhart campaign on flint bottle glass. During its first Corhart campaign, the tank contained Corhart Electrocast throughout the melting-end sidewalls, throat, dog-house, and in portions of both the superstructure and the melting-end bottom. . . . For the second campaign, the use of Corhart Electrocast was extended to include additional superstructure, and a larger portion of the melting-end bottom (as well as the entire refining-end sidewalls, and a portion of the refining-end bottom).

The following is the operating data for both campaigns. We believe you will agree that the increased production figures fully justify the description above—"*Progress* with Corhart."

	8/14/39 to 1/8/42	3/5/42 to 1/19/45	Percent of Increase
Melting Area	770.5	770.5	0.0%
Total Days Life	870	1,051	20.8%
Total Operating Days	803	1,018	26.8%
Total Tons Glass Produced	75,631	102,899	36.0%
Tons Glass Per Day (Life)	87	98	12.6%
Tons Glass Per Day (Operating)	94	101	7.4%
Tons Glass Per Sq. Ft. Per Life	98.15	133.54	36.0%

On the third Corhart rebuild of this tank, now completed, the use of improved Corhart Electrocast products was extended. Further progress is expected. Corhart Refractories Company, *Incorporated,* 16th and Lee Streets, Louisville 10, Kentucky.

*Not a product, but a registered trade-mark.

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THE STRENGTH OF GLASS AS AFFECTED BY DEALKALIZING ITS SURFACE . . .

(*Continued from page* 371)

Improving the strength of glass by bringing its surface into a state of compression is a principle known and practiced for a long time.

The formation of a surface layer of higher chemical resistivity and prestressed under compression should not only improve the tensile and impact strength of glass, but even more so its fatigue endurance. The fatigue of glasses, that is, the decline of strength of a loaded specimen with time, must necessarily involve some chemical reaction of the glass surface, because the mere passage of time cannot have an effect upon its strength value. The fatigue of glass is not a mechanical phenomenon but belongs in the same group as corrosion fatigue of metals or failure of rubber when flexed in an oxygen containing atmosphere. Its exact mechanism is not yet known but it seems that the adsorption of a water film and its reaction with the Si-O bonds, especially with those already under mechanical tension, is one of the dominating factors. If this is true, one should expect that increasing the chemical resistivity of the surface or making it water repellant should increase the fatigue endurance of glass. On the other hand, one should expect that the low temperature treatment with kaolin, leading to a surface containing Si-OH groups decreases the fatigue endurance.

Other Methods of bringing the Glass Surface into a State of Compression

Toughened glass can be traced back into the seventeenth century when it was introduced as a toy, the Prince Rupert drop. Molten glass was chilled by allowing it to drop into water. The pear-shaped pieces were very strong and resistant to breakage, but breaking off the tail made them burst into innumerable fragments. The rapid cooling of the liquid glass causes the skin to solidify at a stage where the core is still much hotter than the skin, due to the low thermal conductivity of glass. On further cooling, the core of the drop attempts to contract against the restraint which the now rigid skin exercises upon it. As the result, the core will become highly stressed in tension whereas a strong compression is built up in the skin. So long as the compressed skin surrounds the drop it can scarcely be crushed and withstands severe blows with a hammer. Breaking off the tail, however, causes the core of tension to extend to the surface and destruction results with almost explosive violence.

From this toy to the toughening of commercial glassware is a long step. In 1875, De la Bastie[11] in France found that lamp chimneys could be made more resistant to thermal shock by immersing them in oil, when they were still red hot. The principle is the same as that of the Prince Rupert drop: the glassware is strained, the outside being in a state of compression.

The method of chilling the glass has undergone numerous modifications and has changed from a skill into a process which is now scientifically controlled. In most cases the oil bath has been replaced by an air blast or by spraying metal powder against the surfaces.

Tempered or toughened plate glass has a modulus of rupture measured by transverse bending of about five times that of the untreated glass. Its high tensile strength naturally reflects on its thermal endurance and its ability to resist impact.

Another independent discovery which uses the same principle, namely, bringing the surface layer into a state of compression, is the "compound glass" developed by O. Schott (1892)[12]. This method accomplishes the aim by casing two or more glasses of different coefficients of expansion, so that the resulting stress is better distributed and the danger of explosive fracture is avoided. I. A. Smirnova (1940)[13] found that the same can be accomplished by casing two glasses which have the same thermal expansion but different setting temperatures. The effect of weakening and strengthening the glass by coating its surface with an enamel layer belongs too in this group. J. E. Ablard[14] reports that by properly adjusting the coefficient of expansion of vitreous enamel used for the decoration of bottles their thermal endurance can be increased. Increased resistivity to thermal shock is observed whenever the enamel is under compression and the bottle itself under slight tension.

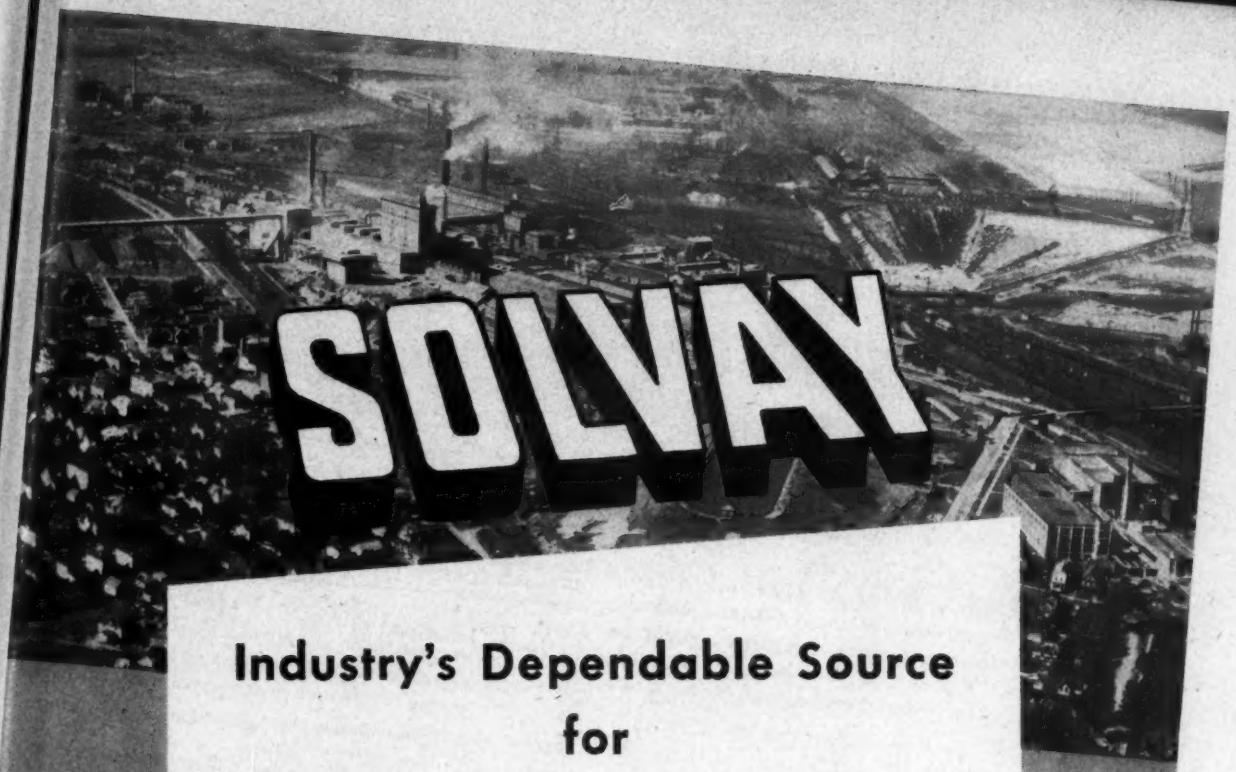
An entirely new method for producing a glass surface under compression has been discovered by E. C. Leibig[15]. He found that this effect can be accomplished by chemical means. In his experiments on the surface staining of glass by copper compounds he found that treating rods of a borosilicate glass with molten cuprous chloride increased their strength up to 60 per cent. He explains this improvement by the formation of a skin stressed under compression. The sodium ions, or at least the majority of these ions, are replaced by copper ions. Sodium oxide imparts higher thermal expansion to the glass than the equivalent amount of copper oxide and as a result, the copper containing glass surface will not contract as much on cooling as the bulk. The difference in contraction on cooling brings about a state of compression in the surface layer and cracks will not propagate readily through this skin.

Originally Leibig experimented with a glass of the Pyrex type, which has a low alkali content and a coefficient of expansion of only 0.0_532. From the viewpoint of alkali exchange and modifying the surface characteristics, the choice of glass was not a favorable one. He therefore applied his invention to a glass with a higher alkali content and a thermal expansion of 0.0_550. The strength of this glass could be increased by 165 per cent —as compared with 60 per cent in the case of the Pyrex brand glass—by immersing the glass rods for one hour in fused cuprous chloride at 650°C.

Compared with the mechanical method of casing this new process offers one principal advantage: the low expansion layer surrounds the treated article completely. Schott's method necessarily produces a discontinuity, where the article is severed from the working tool. This interruption represents a weak spot, as we have seen in the case of the Prince Rupert drop.

This review shows that there exist several methods to bring the surface layer of a glass under compression:

(*Continued on page* 388)



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THE STRENGTH OF GLASS AS AFFECTED BY DEALKALIZING ITS SURFACE . . .

(*Continued from page* 386)

(1) the thermal method, tempering or toughening glass by controlled chilling,

(2) the mechanical method of casing two glasses of either different coefficients of expansion (O. Schott) or different setting points (I. A. Smirnova),

(3) the chemical methods, lowering the coefficient of expansion of the surface layer by removal of part of its alkali,

(a) surface reaction with combustion gases (Murgatroyd, Peddle)

(b) base exchange with fused CuCl (Leibig)

(c) surface reaction with metakaolin (Williams and Weyl).

There are no data available yet which would allow us to compare the efficiency of these different methods. Nevertheless, even a preliminary comparison might be of some interest. That can be done only by discussion of the factors which determine the usefulness of the methods separately.

A. Stress Distribution

All methods have in common that they produce a surface layer which is prestressed under compression. With the exception of the mechanical methods which are based on the combination of two different glasses to one piece all other methods produce a continuous layer coating the whole object.

The depth of the compressed layer varies considerably. The thermal and mechanical method both produce relatively deep zones stressed in compression; the chemical methods change the glass surface to a depth which is less than 1 mm. and in most cases of the order of 1/10 mm.

The discontinuity in the compressed surface layer is definitely a disadvantage and has restricted the usefulness of Schott's compound glasses. The thickness of the surface layer, however, represents a factor which is more difficult to evaluate. There is, of course, a lower limit, because a surface layer does not fulfill its purpose of preventing surface cracks from propagating if it is easily scratched through during normal use. Whether it is favorable to increase its depth beyond this limit or not depends to a large extent on the shape and dimensions of the article. For thin-walled glasses it must be dangerous because the high compression surface stress has to be balanced by internal tension stress of equal total value. Samples which had been "toughened" by tempering may actually be weaker than the untreated specimens, if the layer of compression is too deep. This is also the reason why thin-walled glass cannot be toughened successfully. This can be readily understood from Figures 1 and 2 representing schematically the stress distribution of prestressed beams with and without the application of a load. For tempered glass one assumes as a first approximation that the stress distribution is parabolic. This function, which can be derived mathematically from the thermal conductivity of the glass is

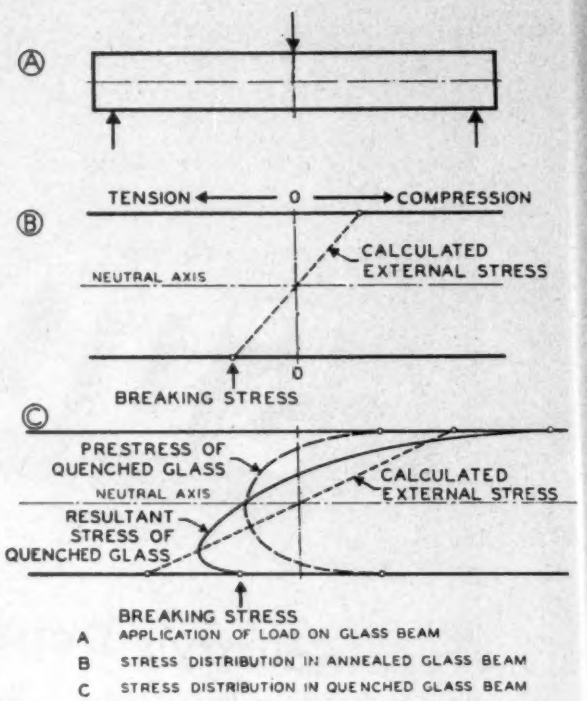

Fig. 1—Stress distribution in glass loaded to failure.

to be modified if the heat loss due to radiation from the interior shall be taken into consideration.

B. Effect on Light Transmission

With the exception of Leibig's method, which aimed to produce a colored glass, the transmission for ordinary light is not affected by the various treatments. For polarized light, however, this is different. Glasses toughened by tempering or by casing are strongly birefringent. The surface-treated glass, however, shows no evidence of reaction whatsoever when viewed perpendicularly to the surface. Only if a section is examined under a low power microscope can the stress distribution be detected with polarized light.

C. Workability of the Treated Glass

Glasses which have been toughened by either the thermal or the mechanical method have practically no neutral zone. The glass is either under strong compression or under strong tension. There are theoretical reasons (thermal conductivity) in case of the thermal method and practical reasons (thickness of cased layers) in case of the mechanical method why that cannot be changed. The two stresses, tension and compression, are balanced and whenever we try to drill a hole or cut the glass with a saw, there is danger that the delicate equilibrium may be upset and fracture occur. The lack of a neutral zone of reasonable dimensions limits the workability of the treated glass.

This limitation does not exist for glasses treated by one of the three chemical methods. As one sees from the stress diagram Figure 2, the bulk of the glass is practically stress-free.

D. Factors Concerning the Manufacture

Besides the weakness mentioned under point (a) the main limitation of the cased glassware lies in its manu-

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Aaron and Rosie Winters found it impractical to enter into extensive operations for the development of their Borax claim, and sold it to a group of organizers, subsequently to become the Pacific Coast Borax Company, more popularly known as the producers of 20 Mule Team Borax, Boric Acid and its derivatives.

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facture. It requires skill, and does not lend itself readily to mass production.

The thermal method, after considerable efforts, has been brought under control and could be extended to various types of glassware.

In this point we shall restrict our comparison to the three chemical methods.

The reaction with gases during the annealing seems to be the most promising from the manufacturing angle. One has practically nothing to do but anneal the ware in an atmosphere containing acidic gases, such as SO_2 or HCl. The method requires practically no extra cost and little additional handling of the ware (removal of the Na_2SO_4 or NaCl by washing). Why, then, is this method not generally applied? There exist a number of patents covering the use of acidic vapors and gases during annealing in order to improve chemical resistivity. The method is not very efficient for improving mechanical strength, and the results of Peddle and others must have met with considerable scepticism because they were not sufficiently understood. The treatment offers a small improvement for practically no additional cost. The main difficulty in improving this method lies in the corrosive action of acidic gases on the construction materials of the lehr, especially if substances like sulfurylchloride, hydrochloric acid or other strong mineral acids are used. In order to make this method more efficient, the concentration of the reagent and the duration of the exposure would have to be considerably increased. Nevertheless, it seems to be worthwhile to keep this method in mind as a potential source of improvement.

The second chemical method is based on a base exchange reaction. Introducing copper into a glass leads to a colored product but the color is not an obstacle for many types of ware such as electric insulators and besides, this reaction might be extended to other salts such as thallous chloride, which do not produce colored ions.

The main disadvantage of this process is the hazard connected with handling large melts of cuprous chloride or similar compounds in the glass plant. These materials have a considerable vapor pressure at the reaction temperature and are poisonous. For small objects Leibig designed a furnace containing the salt bath under a well ventilated hood. The inevitable loss of chemicals makes this process costly.

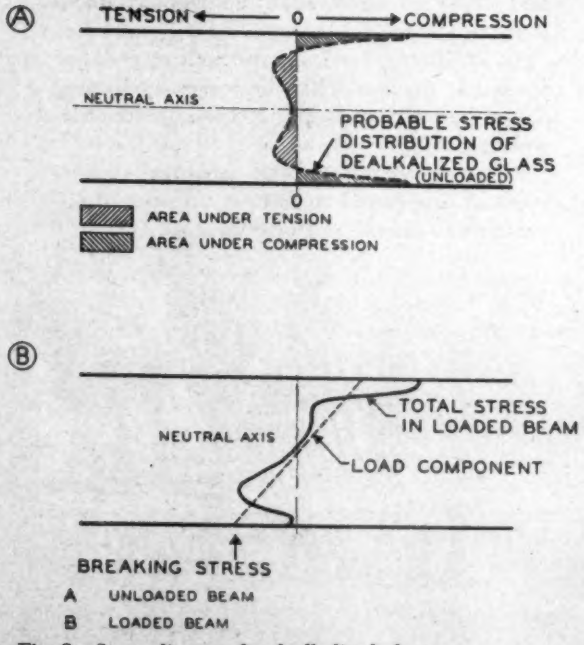


Fig. 2—Stress diagram for dealkalized glass.

The most appealing feature of Leibig's process is the speed. The intimate contact of the glass surface with a high concentration of the reagent made it possible to achieve a 165 per cent increase in strength within one hour. This speed is due to the fact that the removal of the alkali, say in the form of NaCl, does not depend on diffusion processes alone but is aided by the convection currents of the salt bath.

How does the metakaolin method compare with these two chemical methods? Using this method, the glassware can be left in an ordinary annealing furnace without special precautions except temperature control. There is no expensive salt bath, nor are there fumes. The new method is much more efficient than the gas reaction method, but it requires additional handling. The glassware has to be cooled before the treatment can be applied. The treatment itself consists either of spraying on a clay-slip or of a dipping and drying operation. After applying the reagent the ware has to be heated and kept at the optimum reaction temperature for a period of several hours. After cooling, the ware has to be cleansed. The latter operation, of course, is common to all three chemical methods.

The advantage of the new method is the use of inexpensive and non-poisonous materials. The process can be better controlled than one involving a salt bath, because the efficiency of a salt bath decreases with the accumulating alkali.

From this brief and rather incomplete comparison one can readily judge which place our new method could fill in the glass industry. It would not be in a direct competition with existing methods, but would be used chiefly where

(1) In addition to improving the mechanical strength and the fatigue endurance of the glass one desires to increase its chemical resistivity or its electrical surface resistance.

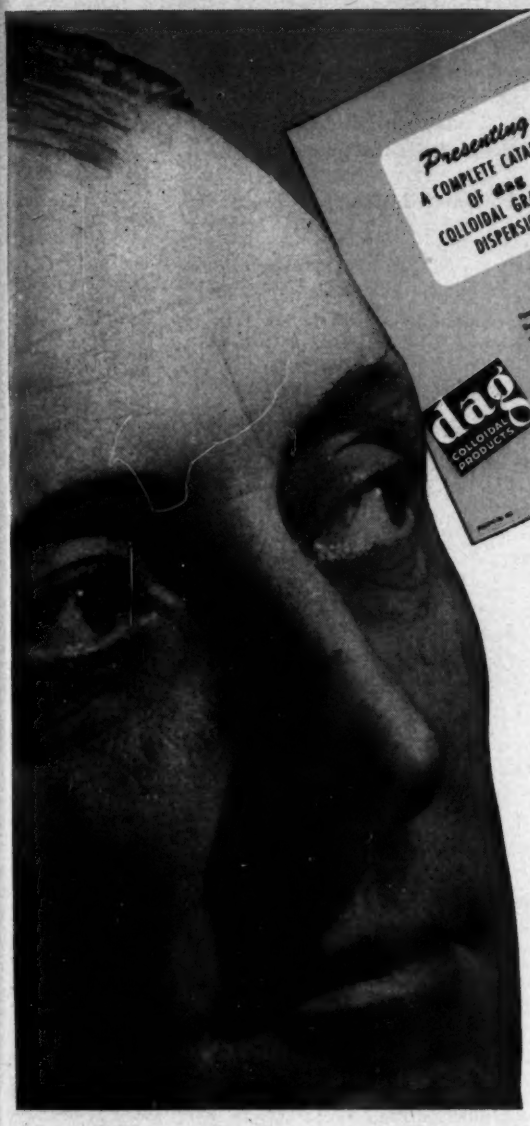
(2) The tempering process cannot be applied because of limited workability of the toughened product.

(3) Its isotropic strain distribution is an asset and tempered glass could not be used. (Combination of toughened glass with Polaroid.)

These conclusions seem to make it worthwhile to take up some quantitative studies on the strength properties of glass as affected by dealkalizing its surface.

REFERENCES

1. H. S. Williams and W. A. Weyl, The Glass Industry, *26* (1945) No. 6, 275, No. 7, 324.
2. J. B. Murgatroyd, Glass (London) *8* (1931) 272.
3. C. J. Peddle, Journ. Soc. Glass Techn. *21* (1937) 177-186.
4. J. Boow and W. E. S. Turner, Journ. Soc. Glass Techn. *22* (1938) 357-371.
5. A. A. Griffith, Phil. Trans. Royal Soc., London *A-221* (1920) 163-198.
6. A. F. Joffe, The Physics of Crystals, McGraw Hill (1928).
7. A. Smekal, Ergebnisse der Exakten Naturw. *15* (1936) 106-188.
8. J. T. Littleton, Phys. Rev. (2) *22* (1923) 510.
9. A. Threlfall, Philosoph. Mag. *30* (1890) 991.
10. F. W. Preston, Journ. Soc. Glass Techn. *17* (1933) 5-8.
11. De la Bastie, Bull. de la Soc. D'Encouragement (5) *2* (1875) 132.
12. O. Schott, Sitzungsber. d. Ver. zur Beforder d. Gewerbefleisses (1892) 161 and German Pat. 61,573 (1892).
13. I. A. Smirnova, Trudy Moskov Khim-Tekh. Inst. Mendeleeva (1940) 93-112.
14. J. E. Ablard, Ceramic Industry *37* (1941) No. 12 (Dec.) 40.
15. E. C. Leibig, U. S. Pat. 2,075,446.



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COLORED GLASSES . . .

(*Continued from page* 375)

sive alkali content favors these latter compounds, too; whereas lack of alkali favors the equally undesirable selenides and polyselenides.

Nevertheless, in the initial stage of the melt both selenite and selenide are required for the ultimate formation of elemental selenium.

The delicate equilibrium of selenium with its compounds unfortunately shifts under the influence of annealing or irradiation, such as sunlight. These complicated and disturbing processes appear to be controlled by continued oxidation of selenides, selenium and iron compounds, for instance, by arsenic. On the other hand, arsenic assists in stabilizing the color obtained from melt to melt.

The color shifts encountered in the presence of Na++ (brown), K++ (pink) and Pb++ (topaz) are explained by the high polarizability of elemental selenium.

In spite of the complexity of the system which does not permit the quantitative evaluation of batch constituents required for a particular hue, the study of this extensive chapter is warmly recommended to the glassmaker. These reactions also control part of the ordinary decolorization process.

Selenium Ruby

Fascinating details are reported concerning the formation of specific types of the cadmium sulfoselenide now generally recognized as the chromophore in selenium ruby glasses.

The first requirement for the formation of any cadmium sulfoselenide ruby is the retention of sulfur and selenium. This is usually accomplished by Zn++, in a grouping which resembles zinc sulfide or sulfozincates. With decreasing temperatures the sparingly soluble cadmium sulfide precipitates with a certain number of selenium ions, depending on concentrations and supersaturation. At higher temperatures the lattice contains more selenium, even if the original formula was identical. Very high concentrations of zinc prevent the formation of selenium ruby because the equilibrium favors the zinc compounds of sulfur and selenium rather than those of cadmium. The practical difficulties encountered in manufacturing reproducible selenium ruby colors are increased by the volatility of selenium, sulfur and cadmium and the segregation of heavy selenides towards the bottom of the tank. The nature of the compounds used in the batch is also important. The remarkable retention of small batch additions obtained with metallic reducing agents is described.

The temperature of pressing and, more so, the minimum temperature reached before pressing, decisively influence the color of the manufactured wave because the development of the right nuclear sizes during crystallization is critical. Time temperature studies taken from the literature are presented that should encourage similar studies for special problems in the ordinary plant.

A sharp cut-off absorption curve of selenium ruby filter glasses seems to require crystal growth from many nuclei formed at low temperature. It is not ordinarily possible to use a glass that strikes on first cooling for this purpose, since in this case few large crystals are formed. The type of ruby that strikes on reheating contains many nuclei and is more likely to have the desired cut-off absorption curve.

Other Non-Metallic Element Colors

Among rarer non-metallic element colored glass described in the monograph are black cobalt selenium glass, tellurium glass and some phosphorus glasses.

The section discussed in this review fills the largest gap in our present knowledge of colored glass.

N. J. KREIDL

FRENCH GLASS INSTITUTE REORGANIZED

L'Institute du Verre, Paris, France, created in March 1942 by the Comité d'Organisation des Industries du Verre, has undergone a complete reorganization. The Institute was formerly under the direction of this committee which was appointed during the German occupation for the purpose of administering its activities.

Due to a very limited staff and a lack of incentive, as well as industrial means, the Institute's activities, until now, have been severely restricted.

However, in April 1944, Mr. Bernard Long was appointed Director General of the Institute, his first work being the study of the transformation of the Institute into a corporation. This was accomplished with the agreement of the committee of organization. It was felt that only in this way would the Institute have the independence and means to carry on its work. Among the problems involved in reorganization was a considerable amount of documentation and the planning of work in cooperation with scientific institutions.

One benefit already derived from the reorganization of the Institute into an incorporated joint stock company has been the recent affiliation of the trade union of glass manufacturers known as the Federation des Syndicats de fabricants de Verre.

The aims and purposes of the Institute are stated to be as follows: 1) to bring together and to keep up to date the most complete scientific, technical, economical documentation on glass and the productions of the glass industry; 2) to increase the scientific and technical propaganda for glass with the exception of any direct commercial propaganda, to disseminate information about glass to all those who make use of it, including students, technicians, the general public; 3) to assume for those who make use of glass and those who manufacture it the control of raw materials as well as that of glass as a material and the finished products; 4) to direct and achieve by itself or with the assistance of other institutions scientific and technical researches the aim of which will be to improve the existing processes of manufacture or to set up new techniques and new products.

• The Owens-Illinois Glass Company will build a $3,500,000 bottle factory in Longview, California, as soon as machinery is available. Working drawings have already been completed by Austin Company. The plans call for 14 connected buildings.

L-O-F NAMES PLATE GLASS SALES CHIEF

The Libbey-Owens-Ford Glass Company has announced the appointment of E. R. Pierce to the post of Manager of plate glass sales, effective August 1.

Mr. Pierce joined the organization in 1939 and, during the war period, has been in charge of aircraft sales. Previously, he had been associated with the New York office of Libbey-Owens-Ford in charge of the Hartford, Conn., branch office. Prior to his association with the company, Mr. Pierce was president and general manager of the E. R. Pierce Company, Detroit.

J. T. Sings, formerly assistant to Mr. Pierce, will succeed him as Manager of aircraft sales.

LONGNECKER RESIGNS FROM OVERMYER

In a recent announcement by C. P. Overmyer, Sr., President, Overmyer Mould Company, it was stated that Morton Longnecker, executive vice president and treasurer, had resigned, effective July 1.

In making this announcement, Mr. Overmyer also stated, "Mr. Longnecker has had a large part in the development of Overmyer Mould Company since his association with the organization in 1922, and his services in an advisory capacity will still be available."

At the same time, it was announced that Cedric Briner, a member of the board of directors in charge of the pattern department and foundry, was also resigning. This necessitated a reorganization and election of a new member to the board.

The present board members are C. P. Overmyer, Sr., president and general manager; C. P. Overmyer, Jr., first vice president and general factories manager; E. E. Sandifer, secretary and treasurer; Lowell Roesner, second vice president and general sales manager, and Earl Flatter, third vice president and manager of plant operations at Winchester.

George Smeltzer is vice president and factory manager at the Greenburg plant, and A. J. Calpha is vice president and manager at Sprinfield.

C. P. Overmyer, Sr., will continue as active head of the company. He has held the position of president and general manager since the company's inception in 1920.

• Dr. L. B. Arnold, Jr., has joined the staff of Arthur D. Little, Inc., Cambridge, Mass. Dr. Arnold was previously with E. I. du Pont de Nemours & Co., Inc., and more recently an Assistant Director of the Chemistry Division of the Metallurgical Laboratory at Chicago.

• It has recently been announced that the Spencer Lens Company will now operate under the name American Optical Company, Scientific Instrument Division.

PITTSBURGH PLATE STATES POSITION IN ANTI-TRUST SUIT

In a recently issued pamphlet addressed to stockholders and employees, H. B. Higgins, president of Pittsburgh Plate Glass Company, outlined the position of his company and its attitude with regard to the suit recently filed by the Department of Justice against Pittsburgh Plate and other companies. Mr. Higgins' statement follows:

"For over 60 years, the management of Pittsburgh Plate Glass Company has sought to achieve these goals: good, honest products, adequately and economically distributed under sound business policies, at reasonable prices; appropriate dividends for shareholders with an adequate portion of earnings plowed back into improved facilities and constant research for new and better products; jobs for workers at good pay; service to the public.

"With genuine regret, management must report to its shareholders, employees, and the many friends of the Company, that a civil suit has been filed under the Anti-trust laws against Pittsburgh Plate Glass Company and other companies in the flat glass industry and certain other corporations and individuals. The original Anti-trust Act, known as the Sherman Act, was passed by Congress in 1890. In the fifty-five years since 1890 this is the only suit of this nature which has been instituted against the Company.

"Some of the objectives of the suit are as follows: to forbid sale of the Company's products f.o.b. factory, freight equalized with nearest competing producer's plant (a long competition); to require the Company to license its patents to any applicant on a royalty-free basis; to forbid the use of a manufacturer's wholesale list price by which, for generations, distributors and dealers in flat glass products have been able to determine their costs; to require the Company to divest itself of its distribution outlets through which, since 1896, its customers have been served; to require the Company to sell all except one of its flat glass plants.

"There are numerous other stated objectives in the suit, some of which affect all of the defendants, some of which affect only some of the defendants. It is not possible to state in this brief review all of the contents of the eighty-two pages of the Government's Complaint or to be technically comprehensive in this statement.

"We must prepare the case for trial. This will involve an arduous effort on the part of many of our executives and personnel. It will inevitably impair, to some extent, the effectiveness of our efforts in production for the important war and reconversion period which lies immediately ahead. We undertake this task regretfully but with firm determination.

"The Company has cooperated with the Department of Justice. Its business methods have been disclosed from the very inception of its operation in 1883. We recognize that the enforcement of the Anti-trust laws is the duty and responsibility of the Anti-trust Division of the Department of Justice and that that Division possesses the discretion and power to institute such proceedings. But we have confidence that interpretations of Anti-trust laws which would destroy the efficiency of production and distribution, the stability of business, the security of investments, the opportunities for jobs, and the dependability of products and of service to the public will not prevail in our American courts."

KINGDON JOINS EISLER ENGINEERING

The appointment of Howard E. Kingdon to the post of Chief Engineer and Manager of the Transformer Department has been announced by The Eisler Engineering Company of Newark, New Jersey.

In his previous connections, Mr. Kingdon has served in the Transformer Engineering Department of General Electric Company, as Chief Transformer Engineer of the English Electric Company of Canada and as Chief Transformer Engineer and Assistant Manager of the Commonwealth Electric Corporation, Ltd., of Ontario. In 1937, he was made Works Manager of the Transformer Division, which position he held until recently. Mr. Kingdon assumed his new duties July 1, 1945.

NEW APPOINTMENTS MADE BY CORNING

The appointment of Casper J. Stacey to the post of Assistant Manager of the company's Bradford, Pa., plant has been announced by Corning Glass Works. Mr. Stacey was formerly Assistant Manager of the Wellsboro, Pa., plant. The promotion of Harold W. Roland from the position of Plant Engineer to that of Production Superintendent was simultaneously announced.

Mr. Stacey joined Corning Glass Works in 1939 as a member of the engineering department at the Central Falls, R. I., plant. He successively served at Corning, Wellsboro and Charleroi, Pa., and, after being transferred to Wellsboro, became Assistant Manager until his present appointment.

Mr. Roland has been associated with the company for many years and has held positions in the electrical and other trades departments. In January 1945, he was appointed Plant Engineer.

REEVES-ELY APPOINTS TECHNICAL DIRECTOR

Announcement that F. F. Sylvester has been appointed Technical Director in charge of Research and Engineering has been made by the Reeves-Ely Laboratories, Inc., of New York City. Mr. Sylvester will act in this capacity for the parent organization and affiliated companies.

Formerly with the Lewyt Corporation as Technical Director and General Sales Manager, Mr. Sylvester has a well-rounded background of engineering and commercial business experience. He has spent many years in the communications and electric fields in connections with prominent producers of radio and kindred apparatus.

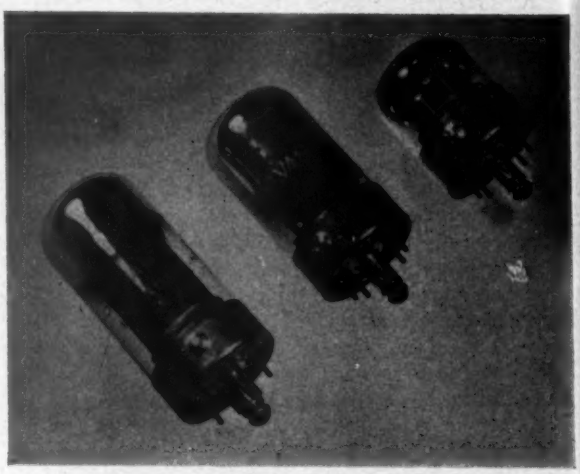
• T. Carter Vaughan, a member of the research staff of Libbey-Owens-Ford Glass Company, Toledo, Ohio, has been elected to membership in the honorary scientific society, Sigma Xi, by the Virginia Polytechnic Institute section of the Society.

TECHNICAL SOCIETIES COUNCIL FORMED

Seventeen professional and technical societies of the Kansas City area have joined forces to establish the Technical Societies Council for unified action in matters pertaining to the development of scientific endeavors.

Some of the principal objectives to be advanced immediately include support for establishing better technical and scientific libraries in this region; to encourage the establishment of educational courses of a technical and scientific nature in the schools in this area and coordinate the vocational guidance activities of the constituent organizations; to cooperate with civic, educational and government agencies in matters requiring professional assistance.

The following officers were elected at the organization meeting held in Kansas City on July 9: Chairman, Dr. W. M. Hoehn, member of the American Chemical Society and laboratory director of the George A. Broen & Company; Vice-Chairman, C. M. Lytle, Missouri Society of Professional Engineers, with the Kansas City Power & Light Company; Secretary-Treasurer, Charles Briggs, member of the American Society of Mechanical Engineers, with the Burns & McDonnell Engineering Company.



SYLVANIA "LOCK-IN" ELECTRON TUBES

Featuring sturdy mechanical construction to withstand vibration, shock and rough service in aircraft, automotive and industrial applications of radio and electronic control, Sylvania Electric Products announces lock-in tubes to provide many electrical advantages for high and ultra high frequency applications.

Tube bases of all metal design provide shock-proof positioning of the tube in its socket. Solid socket pins, which, it is said, provide excellent mechanical and electrical contacts with socket parts, are welded directly to the tube elements. Utilizing glass "header" construction permitting the use of heavier element supports, direct bonding of the pins to glass and more durable glass envelope construction, lock-in tube design reduces lead inductance and inter-element capacity.

These combined mechanical and electrical features, it is felt, make this type of tube particularly well suited for the higher frequencies allocated for television, FM, aircraft radio and railway train communication.

HOMMEL APPOINTS McGOVERN FOR NEW DIVISION

The O. Hommel Company of Pittsburgh, Pa., announces the appointment of Charles F. McGovern as a member of the staff of the newly organized Chemical and Equipment Division. Mr. McGovern has been associated with the chemical industry for many years and was previously connected with the American Cyanamid and Chemical Corporation.

The new division of the O. Hommel Company will act as sales agent for principal manufacturers of chemicals, oils and specialties used in the paint, ceramic and general industrial field.

BOOK REVIEWS

Time Study and Motion Economy for Supervisors
by James D. Shevlin

This recently published 76-page book presents in one convenient manual data for supervisors who wish to streamline the job operations of the crew for which he is responsible. The manual consists of three parts: Motion Study, Time Study and Charts and Diagrams.

Motion Study includes, among other subjects, information on pre-position tools and material, proper work areas, gravity feed hoppers, holding devices, etc. Time Study covers how a time study is made, the foreman and time study, time study and cost reduction, etc. Charts and Diagrams, printed in four colors, illustrates time and motion studies before and after completion. In addition, there are supplementary line-drawings and other illustration material in one color. All use of material is directly related to supervision needs.

Published by the National Foremen's Institute, Inc., Deep River, Conn. The price is $2.00 f.o.b.

Encyclopedia of Chemical Reactions
by C. A. Jacobson, Ph.D.

The first of a series of five volumes to be published before the end of 1947, Volume One contains practically all published chemical reactions, briefly described and given in equation form.

The 3,000 entries in the first volume include reactions involving the elements Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron and Bromine. Entries are alphabetically arranged first as to the formulas of the reactants and next as to reagents.

Published by the Reinhold Publishing Corporation. The price is $10.00.

• Reconstruction Finance Corporation has published a booklet, "How To Do Business with RFC," listing approximately 3,000 items of Government-owned surplus property which RFC handles as a disposal agency.

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Glass Tank Furnaces contains 105 figures and illustrations—75,000 words typed in two columns and produced by the lithoprint process. Cloth bound, price $3.50. Foreign $4.00, F.O.B.

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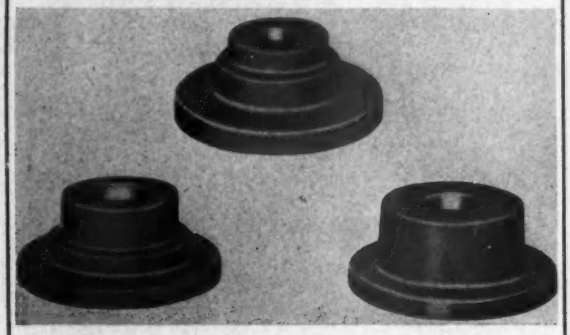

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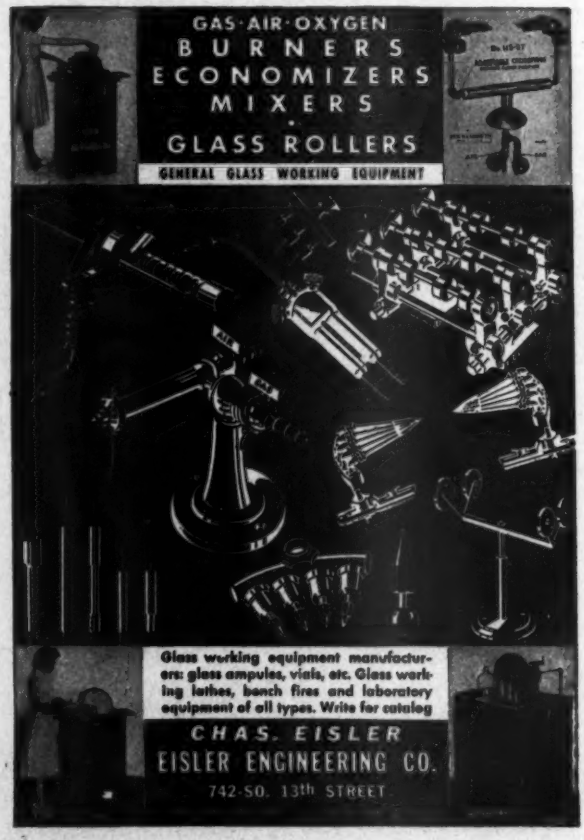
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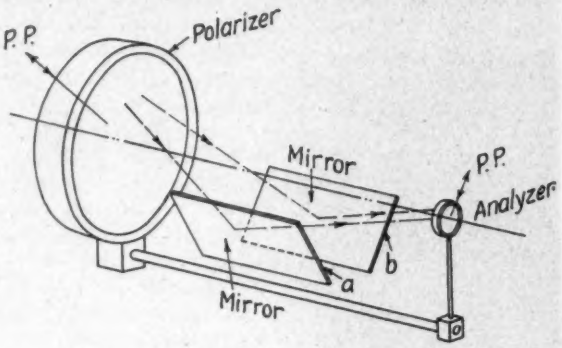
AN IMPROVED METHOD FOR DETECTING CASEHARDENED GLASS AS A MIRROR COMPONENT . . .

(*Continued from page* 372)



Edge (a) is parallel to, and edge (b) is perpendicular to plane of polarization (P.P.) of light from polarizer.

Fig. 3.

to the plane of polarization of the incident light or perpendicular to it, in a position such that light from the polarizer will be reflected by the mirror into the analyzer. This is illustrated in fig. 2. In either of these positions no reflection from the front surface of the mirror is visible. The light reflected from the silvered surface itself shows the characteristic interference fringes.

When the mirror is oriented as described above, the fringes near the edge are not visible. They are visible, however, when the mirror is at an angle of 45 deg. with the plane of polarization even though the surface glare is then at a maximum (see fig. 3).

By the use of this proposed procedure, mirrors can be tested without first stripping off the silvering and other backing. This results in the following advantages: (1) identification of casehardened glass as a mirror component is as positive by the proposed method as by the one now in use, (2) the mirror is not destroyed. This permits the performance of both the salt-spray test for corrosion resistance and that for casehardening, as well as other tests, on the same specimen. Further, the visible evidence of the effect of the salt-spray test on the silvered surface is not destroyed. (3) The method is very rapid. It requires no more than a few seconds per determination, or about 2 per cent of the time required for the test now in use. (4) Dangers due to the use of the highly corrosive concentrated nitric acid are eliminated. (5) There is no need for modifications of or additions to the equipment needed for the test now in use. (6) The method is very simple and convenient.

• Kenneth W. Moore, formerly chief of the photographic section of the Armour Research Foundation, Chicago, has joined the staff of the Midwest Research Institute, Kansas City, and will be in charge of the photography and optics department. For the past one and one-half years, Mr. Moore served as a Lieutenant on the intelligence staff of the 5th Air Corps.

B. F. FENNESSY REJOINS O. HOMMEL

O. Hommel Company has made the announcement of the return of B. F. Fennessy to its staff as Sales Representative with headquarters in Chicago. His territory will include Indiana, Wisconsin, Minnesota, Illinois and part of Michigan.

Mr. Fennessy left the company in 1925 to represent Harshaw in Chicago and from there went to the Certain-Teed Products Company as head of their Industrial Division. In this capacity, he became familiar with the pottery industry.

BELGIAN GLASS AND POTTERY INDUSTRIES

The Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce, recently made the report that, although the plant facilities of the glass and pottery industries are virtually intact, lack of coal, kaolin, feldspar, plastic earth and shortage of skilled help combine to keep the Belgian ceramic industry operating at about one-eighth of its prewar activity. Of the shortages affecting both the ceramic and glass factories, coal is the most glaring. Once this shortage has been relieved, the industries should very rapidly be able to place themselves in a position to export.

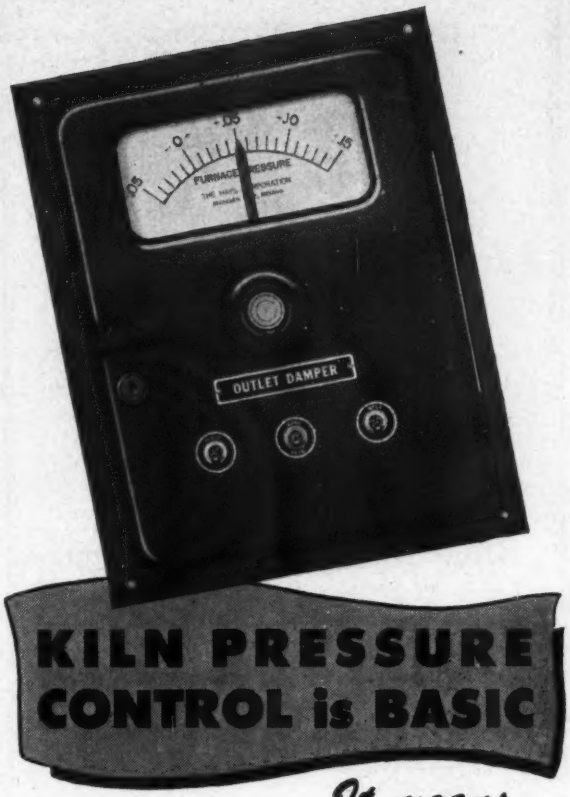
The coal supply has been deficient since the liberation of Belgium and has been further aggravated recently by strikes by the miners. Efforts to procure coal in Germany have been of little avail to date. Plans have been advanced to employ German and Polish miners in Belgian mines to ease the coal shortage. However, it is difficult to predict the repercussions of securing such foreign labor if it were available.

The ceramic industry has been losing its labor supply to the better paying industries in northern France and to the Allied Armies. Although the industry is not affected at present by these labor shifts because the lack of coal keeps it from operating at full capacity, it may be a serious matter once the coal situation rights itself.

Six of fourteen blown glass tableware plants are producing at about half of their normal capacity and the industry has plans for rotating production in the fourteen plants. This one branch of the glass industry may be able to export in the near future if present coal supplies can be maintained or increased. Although the labor supply is not critical in the glass industry, box shooks and other packing materials are in extremely short supply and hamper resumption of normal shipments.

Plate glass plants have been closed because of the fuel shortage. One window glass plant has begun operations and two more are scheduled to resume production in June.

It is impossible to predict immediate developments; however, there is considerable optimism over the probability of an early return to normalcy.



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Hays Automatic Kiln Pressure Control holds the pressure at a constant low value (within plus or minus a few thousandths of an inch water)—high enough throughout the kiln to prevent infiltration of cold air, yet not so high as to force an excessive amount of the hot gases through the refractory walls and arches.

Since the flow of gases from one zone to another is caused by the differences of pressure in the various zones, it is apparent that the control of pressure has a pronounced effect on the distribution of gases and therefore, temperature within the kiln.

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BATTELLE INSTITUTE PUBLISHES NEW BIBLIOGRAPHY

Battelle Memorial Institute, Columbus, Ohio, has just published a 72-page bibliography of the books, publications and patents which have resulted from fifteen years of fundamental and applied Battelle research.

Battelle has published widely in the nation's technical and scientific journals. The new catalogue lists more than 800 such journal contributions, books and patents between the years 1929-1944, inclusive. Subjects included are in the fields of organic chemistry, electrochemistry, chemical engineering, graphic arts, welding technology, applied mechanics, mineral dressing, industrial physics, ceramics, fuels and metallurgy.

INVENTIONS & INVENTORS

(*Continued from page* 377)

a sheet. He scores one surface and then scores the other along a slightly offset line so that when pressure is applied to flex the sheet the fracture will be slightly oblique. Then local heating is applied so that the outer portion of the sheet will expand more rapidly and will separate itself from the disc.

Other plate glass patents include 2,377,684 to Wm. B. Firner of Detroit (General Motors Co.) for double window construction, 2,379,220, to O. D. Englehart of Pittsburgh Plate Glass Co. for apparatus for making such units, and 2,378,291 to F. C. Dulmage, Jr., and T. A. Kauppi (Dow Chemical Co.) for a laminated transparent sheet using no glass. The article consists of a cellulose ether bonded to an acrylate film by means of an intermediate thin layer of a nitrocellulose composition compatible with both.

Glass Wool and Fiber

Two patents assigned to Owens-Corning Fiberglas Corp. by Ed. Fletcher of Newark, Ohio, were 2,377,771 and 2,377,772, Nelson J. Leedy being co-inventor in the second instance. The first of these concerns a traversing apparatus to be used in connection with a drum for attenuating and winding strands of glass fibers. It is desired that these strands be so wound as to build up a barrel-shaped spool. The traversing apparatus consists of two discs moving in opposite directions and bearing pegs or pins. Since the discs are set at an angle to the fiber stream the pegs are in contact with the strand of fibers during only a part of the cycle of rotation of each disc. The timing is such that the pegs on one disc direct the strand across the spool in one direction and then release it to be picked up by those on the disc moving in the opposite direction, giving the desired back and forth traversing movement. The second of these patents concerns the platinum bushings or remelting furnaces from which fibers are drawn and attenuated. The power required to accomplish this melting is several times the theoretical amount, but the inventors report that a considerable saving is accomplished by their new apparatus which places two bushings side by side so that radiation losses and magnetic field losses from the bus bar are greatly decreased. The wiring is such that the bushings are connected in series so that they are electrically heated to melt the glass from a single source of current.

TWO PLANTS IN K. C. AREA TO EMPLOY 1500 MAKING FIBERGLAS

Two plants in the Kansas City area will be utilized for the first volume production of the newly developed superfine glass fibers, according to a recent statement by the Owens-Corning Fiberglas Corporation in Toledo, Ohio. The enterprise will require some 1500 employees in the Kansas City area and a plant conversion program approximating $15,000,000 for machinery and equipment. One of the plants is located in the Blue Valley industrial area and the other in the Fairfax district.

The Blue Valley area Fiberglas plant will be the present Aluminum Company plant and the Fairfax district plant will be the present North American Aviation Corporation Modification Center. Both plants will require some reconstruction and will have to be completely equipped with glass fiber forming machinery.

The new superfine glass fibers will be used by the Navy Department to take the place of kapok in Navy life jackets. Supplies of kapok are urgently needed as they formerly came from Java prior to the Japanese conquest of the island. Current supplies are expected to be exhausted by the first of next year.

The two Fiberglas plants will operate under a Navy contract that calls for a monthly production in excess of a million pounds. This means increasing by nearly a hundredfold the present output by Fiberglas Corporation's Newark, Ohio, Research Laboratories. Production is expected to begin in January.

NEW DIRECTORY OF LABOR MARKET AREAS

The War Manpower Commission has published a new Directory of Labor Areas which lists all communities of 1,000 or more as of June 1, within WMC's 301 classified labor market areas.

Communities are listed alphabetically according to States, and maps are included to further define area locations and boundaries. Information conerning population and leading industries of labor market areas is also included.

WPB CLEARS UP ORDER L-232

To clear any confusion in the industry that may have resulted from the issuance recently of Order L-232 which restricts the use of new lumber for the shipping of glass, WPB has explained that there are no restrictions on the use of second-hand containers or used lumber for packaging flat sheet or window glass.

The order was issued to conserve crating lumber, currently one of the scarcest of war materials, but WPB's Office of Civilian requirements stressed the fact that the order applies to new lumber only. This means that the wooden containers, as well as containerboard packages in which glass is received from manufacturers and wholesalers, can be used over and over again by dealers and retailers in repackaging glass sold to their customers.

BUY WAR BONDS

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